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ABSTRACT

Part of the Global Development Studies Institute series of model curricula, the teacher guide presents strategies for teaching about energy as a global issue. The unit, intended for students in grades 11-14, is designed for one semester. The overall objective is to promote awareness of and responsibility toward the global community through an understanding of the complex and interdependent nature of global issues. The guide is organized into four parts. The first part introduces the energy issue, explaining why it is a global one. The second part presents scientific and historical background information, outlining reasons for the present crisis. The third part analyzes ecological, economic, political, and social elements of the issue. The fourth part explores technological and policy alternatives for the future, including conservation, fossil fuel production, nuclear energy, solar energy, geothermal energy, hydroelectric power, and various energy policies. Basic concepts and information are given for each topic, as well as suggestions for activities and discussion questions. Skills development activities include researching, making surveys, using and analyzing statistics, writing reports, and making policy decisions. Content and skills objectives are listed in the introduction, and charts, graphs, figures, and reading lists are included in each chapter. A glossary and bibliography conclude the document. (Author/CK)

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ENERGY IN AN INTERDEPENDENT WORLD

A Global Development Studies
Case Study

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1979

SO 011 924

To Bill

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

-- T.S. Eliot

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INTRODUCTION AND TEACHERS' GUIDE

That our world is complex and interdependent is generally accepted, but the challenge presented by this fact--to educate ourselves to cope with interdependence--has not been widely met. The educational challenge is twofold:

1) to learn more about our global community, and
2) to develop a sense of our responsibility as members of this community.

These are the goals of global development studies, as defined and pursued by Global Development Studies Institute.

GDSI is a nonprofit, public foundation formed to advance the teaching of global development and interdependence. Founded by Wilmer H. Kingsford in 1976, the Institute has concentrated its efforts on assisting teachers and professors through research, conferences and workshops, individual consultation and communication, and the preparation of publications. The primary focus of the Institute's programs is on the last two years of high school and the first two of college, the years of general education when students have mastered basic skills and can explore the comprehensive concepts of interdependence and global development, before choosing specialized fields of work or study.

The Institute has prepared two model curricula for teachers of global studies--Global Development Studies: Model Curriculum, a full-year course, and Development and Interdependence, a model for a semester-length course. In both, the case study of a nation's development or of a global issue plays an important role in providing the opportunity to study interdependence and development within the context of a particular nation or issue. The case study enables students and teachers to work with data on a real situation and to draw their own conclusions about the global implications and interconnections.

Energy in an Interdependent World, a case study of the global energy issue, is designed for inclusion in or as a sequel to a global studies course like those modeled in the GDSI curricula. GDSI has published two other case studies as well--World Food Supply, a case study of the global issue of food production and distribution, and Focus on Brazil, a case study of national development, analyzing Brazil's social and economic development in the

context of its interrelationships with the rest of the world. It is the emphasis on global context which distinguishes a global case study from more traditional area or issue studies.

Energy in an Interdependent World is intended for students in grades 11 to 14, and assumes basic skills appropriate to this level. It provides opportunities for students to learn and practice skills in researching, making surveys, using and analyzing statistics, writing reports, and making policy decisions. Teaching time for this case study will depend on the students' preparation and on scheduling limitations, but will most likely require between six weeks and one semester. If the study is taught within a global studies course, or as a sequel, students will have gained some familiarity with concepts of global studies and with the complex and systematic nature of world issues. If not, it may be necessary to spend extra time reviewing or introducing basic economic terms or geography skills.

While this case study has been designed for use in or with a global studies course, it can also be adapted or abbreviated for use in other contexts or courses. For example, in a science course, a unit adapted from this study could introduce economic and political ramifications of scientific topics in our modern world and reinforce the concept of interdependent systems, particularly important in the life sciences. A unit on the energy issue is also suitable for a social studies course, whether in American or world history, politics of economics. The energy issue could also provide a theme for an interdisciplinary course or program.

This study is divided into four major areas--an introduction to the energy issue; the scientific and historical background; an analysis of ecological, economic, political and social elements of the issue; and an exploration of technological and policy alternatives for the future.

This is not an encyclopedia of all the facts, nor a book of answers to all our energy dilemmas, but rather a guide to the thoughtful exploration of a complex issue by both teachers and students. For each topic area, basic concepts and information are introduced, and suggestions for activities and discussion questions are provided. Each chapter is followed by references for further reading, and the Bibliography provides an extensive, annotated listing of materials, organizations and ordering addresses.

Energy in an Interdependent World includes 27 charts, graphs and figures, as well as a glossary of important or unfamiliar terms. Student activities include an initial survey of energy knowledge and attitudes, which can be used as a pre-test of the class's background, and a final policy-planning project, which can serve as the basis for a final evaluation. You will also note the selected short readings from energy experts and different countries in Appendix II, p. 107.

It is assumed that each teacher will adapt this guide to suit his or her needs, background and interests, as well as those of the students. Energy in an Interdependent World is only a model, not a rule book, and sections can be lengthened, shortened, altered or eliminated. The important lessons of this energy study, as of any global case study, are an understanding of the complex interrelationships between issues and nations, and the realization that while there are no simple answers and no single right point of view, global cooperation is necessary in every area. Complexity and responsibility are difficult but necessary concepts to grasp in preparing to face the world of tomorrow.

Acknowledgements:

I would like to thank all those who helped me gather information, material and insight on the energy issue, including Messrs. Sonn, Huse and Guerra at PSE&G for information from the energy industry. Secondly, my thanks to my readers and reviewers on the Institute's Professional Advisory Committee, particularly Steve Guild, and to Bill Kingsford, Debbie Truhan, Walt Schaefflor, Ed Babbott and Carlisle Spivey of the GDSI staff and "alumni" whose comments and criticisms were most helpful. A final and large round of applause should go to my typists, proofreaders and officemates, Carole, Debbie and Walt, for their cheerful endurance. And I shall conclude my acknowledgements with a more private thank you to my husband, Rick, who let me in long ago on the truth about entropy.

Anne B. Collier
July 18, 1979

GOALS AND OBJECTIVES

Case Study Goal: To gain an understanding of the complex and interdependent nature of global issues and their importance to our lives through a study of the world energy issue.

Chapter 1 Objectives:

1. To describe the impact of energy issues on our daily lives.
2. To survey different views of the nature and seriousness of problems in the world energy situation, including the perspectives of other nations.
3. To examine basic data and statistics of the energy issue.

Chapter 2 Objectives:

1. To define energy and list its major forms.
2. To compare the amount and quality of energy available from various sources.

3. To relate the concepts of entropy and efficiency to the use of energy.

Chapter 3 Objectives:

1. To explain the importance of the distinction between renewable and nonrenewable sources, and to trace the trend toward greater use of nonrenewable fuels.
2. To explain how available, fossil fuel energy led to more energy-intensive processes and lifestyles, and to trace the exponential growth of energy demand.
3. To identify major reserves of oil and other fossil fuels, and to explore the relationship between energy supplies and demand.
4. To discuss the effect of the sudden rise in oil prices on worldwide awareness of the energy issue.

Chapter 4 Objectives:

1. Environmental: To recognize complex interrelationships between energy production or use and environmental quality.
2. Economic: To describe the effects of higher energy prices on the world economy, particularly in developing countries, and on food production costs.
3. Political: To explain and give examples of the relationships between world politics and geographic locations of energy resources and supply routes.
4. Social: To define the concepts of social costs, elasticity of demand and social responsibility, and to relate these to the energy issue.

Chapter 5 Objectives:

1. To list and discuss methods of conserving energy, and to identify their advantages and drawbacks.
2. To list methods for increasing production of fossil fuels, and to identify possible advantages and drawbacks for each.
3. To briefly describe major alternatives to fossil fuel energy and to identify their advantages and drawbacks.

Chapter 6 Objectives:

1. To analyze factors affecting the formation of national and international policies on energy use, including investment capital, economic growth, political stability, environmental quality and social costs.
2. To briefly outline energy policies of a cross-section of world nations, and to identify some of the reasons for their policy choices.
3. To describe ways in which energy decisions are made in the U.S., to identify important decision-makers, and to discuss the rate at which decisions can be made and implemented.

4. To analyze and evaluate the U.S. energy plan in relation to factors listed in #1 above.
5. To identify and briefly describe international institutions and cooperative efforts in the area of world energy.
6. To formulate recommendations for action at the international, national and local levels.

Skills Objectives:

1. To obtain information from a variety of sources: books, periodicals, primary sources, audio-visual sources, graphs, maps and charts.
2. To conduct a survey and analyze its results.
3. To conduct experiments and draw conclusions from their results.
4. To compare and evaluate information from different sources and points of view.
5. To organize information and communicate it to others in oral or written reports.
6. To extrapolate from graphs of past and current data the likely future trends.
7. To analyze major factors of an issue and to recognize their interdependence.
8. To evaluate costs and consequences of alternatives.
9. To work together in groups to formulate policy recommendations.

CHAPTER 1. WHY IS ENERGY A GLOBAL ISSUE?

Why study about energy? Why is it important to us and to the rest of the world? How did it become an issue of global importance? We shall begin examining these questions in this chapter, but we must warn you from the start that the energy issue, like all important world issues, does not have easy solutions. In fact, there is not even complete agreement on the nature and extent of the problems.

1-1. Opinion survey

Let's begin with a preliminary survey of the opinions and knowledge of this class on the energy issue. It may be easiest to write your answers on index cards, to be collected and tabulated on the blackboard. This is not a test, but rather a survey of the opinions and knowledge you now have. [Note: Some of these questions are adapted from Citizen's Workshop on Energy and the Environment Handbook, U.S. Department of Energy, 1978.]

1. Is there an "energy problem"?
   a) yes b) no c) don't know

2. If so, what is the "energy problem"?
   a) shortage of all kinds of energy
   b) shortage of cheaper fossil fuels
   c) the large amount of energy used and wasted
   d) delays caused by environmental concerns
   e) OPEC's decision to raise oil prices
   f) some combination of the above

3. How soon do you think we may face an "energy crisis" of serious shortages?
   a) before 1985 b) 1985-1990 c) 1990-2000 d) 2000-2050
   e) not for at least 100 years

4. How much will you and your daily life be affected by energy shortages?
   a) very little b) moderately c) substantially
   d) very much

5. How much of its oil does the U.S. import?
   a) less than 1/3 b) 1/3 to 2/3 c) more than 2/3

6. How much of the oil used in Europe and Japan is imported?
   a) less than 1/3 b) 1/3 to 2/3 c) more than 2/3

7. Which country does not export oil?
   a) Saudi Arabia b) Jordan c) Venezuela d) Nigeria
   e) USSR

8. Which country is not a member of the Organization of Petroleum Exporting Countries (OPEC)?
   a) Ecuador b) Iran c) Libya d) Indonesia e) Morocco

9. What fraction of the world's energy consumption occurs in the U.S.?
   a) over 10% b) over 20% c) over 30%

10. What fraction of the world's population lives in the U.S.?
    a) 2% b) 6% c) 10%

11. The heat energy of a gallon of gasoline is equal to:
    a) 5 man-days of labor b) 15 man-days of labor
    c) 25 man-days of labor

12. How much of the energy stored in crude oil is lost between the oil well and the moving car?
    a) 20% b) 60% c) 90%

13. Which of the following is not a fossil fuel?
    a) coal b) oil c) natural gas d) wood

14. How much faster than their rate of production are we consuming our fossil fuels?
    a) 10 times b) 1,000 times c) 1,000,000 times

15. What was the most used fuel in the U.S. 200 years ago?
    a) oil b) wood c) coal d) hydropower

    100 years ago?
    a) oil b) wood c) coal d) hydropower

16. Which fuel provides the largest part of U.S. consumption today?
    a) nuclear b) coal c) oil d) gas e) hydropower

17. Most electricity in the U.S. is produced from:
    a) coal b) oil c) hydropower d) nuclear

18. In the year 2000, the total energy demand in the U.S will be:
    a) the same as today b) twice as much as today
    c) three times as much as today

19. Which of the following environmental problems is not a result of increased energy use and production:
    a) deforestation in the areas around many villages in the developing world
    b) sulfuric acids in the rains of northern New York and Scandanavia
    c) weakened and cracked shells of bald eagle eggs
    d) increase in the carbon dioxide layer of the atmosphere

20. How much did OPEC countries increase the price of oil in 1973?
    a) twice the pre-1973 price b) three times c) four times

21. How many cans can be made from recycled aluminum with the energy needed to make one can from aluminum ore?
    a) 3 b) 5 c) 20

22. Which of the following are possible future sources of petroleum?
    a) synthetic oil from coal b) oil shale c) tar sands d) all of these

23. Which of the following energy sources do you think will prove most productive and beneficial in the future?
    a) nuclear b) solar c) greater use of fossil fuels, such as coal d) variety of renewable sources, such as wind e) some combination of these

Tabulate and discuss the results of your survey. The answers to the factual questions are in Appendix I, p. 105. How well informed on energy is the class? Record the class results for later use.

Conduct this same survey outside the classroom. Each student should survey at least 2 or 3 adults. The results should be tabulated for later use in class.

1-2. Energy in our lives

Most of us have heard or read about the "energy crisis," the oil shortage, the threat of nuclear proliferation and other aspects of the energy issue. We may or may not agree on the nature of the current energy problem, but how does energy affect our daily lives and futures?

Activities and questions for discussion:

1) In a class "brainstorming" session, list as many ways as you can that you yourself use energy on a day-to-day basis. For example, in the past 24 hours you may have used stereos, cars, televisions, heat, clothes washers,

etc. For each use identify the source of energy, for example, oil, coal, electricity. How is the electricity used in your community generated?

2) Assume that a serious energy shortage has occured, and energy use has to be reduced. Divide the class list of energy uses into three categories:

a. energy uses that could be eliminated
b. energy uses that could be reduced or alternatives found for them
c. energy uses that are essential and cannot be cut back

If this energy shortage were specifically a shortage of oil, which energy uses would be affected? how would this affect our lives?

3) Two other important uses for oil, natural gas and, to a lesser extent, coal are 1) sources for petroleum products such as asphalt and paraffin wax, and 2) sources of petrochemicals for the manufacture of products such as plastics, pharmaceuticals and polyester fibers. (See figure 1, p. 5 for a partial list of petroleum and petrochemical products.) How many of these items do you use or encounter daily? For which ones could substitutes be found, if necessary? Which items could be eliminated?

4) How important is the energy issue to our daily lives?

1-3. Energy crisis?

A reduction of energy supplies would certainly affect our lives, but how likely is such a reduction and what areas would be most affected? Experts have varying opinions on the energy issue.

Activity:

Read the sampling of expert opinion in Appendix II, p. 107. You may want to do further readings from these or other sources of expert opinion. (See chapter references for reading suggestions.)

Questions for discussion:

1) Do these sources disagree? If so, in what aspects and why? What are their areas of agreement or majority consensus?

2) Which energy source(s) is most often mentioned as likely to run short?

3) Review the results of the surveys from activity # 1, and compare them with the opinions expressed in the readings. You may also wish to compare them with the results of the Great Decisions '78 survey on energy. (See Bibliography for full citation.) Are there areas of significant agreement or disagreement?

4) How good is general knowledge in the class and outside it, based on responses to the factual questions in the survey? Do you think there is a need for greater awareness and education about energy?

Figure 1. Oil: Bright Promise

Crayons	Paddles	Bubble bath	Permanent-press clothes
Parachutes	Floor wax	Lunch boxes	Disposable diapers
Telephones	Panelling	Phonographs	Playing cards
Enamel	Sneakers	Garment bags	Transparent tapes
Overcoats	Earrings	Windbreakers	Windshield wipers
Bookends	Eyelashes	Soap dishes	Car sound insulation
Planters	Golf balls	Volley balls	Kitchen counter tops
Deodorants	Wet suits	Sleeping bags	Dune buggie bodies
Panty hose	Laxatives	Midi-skirts	Synthetic rubber
Bedspreads	Trash cans	Bread boxes	Electrician's tape
Tubs	Brassieres	Oxygen masks	American flags
Shag rugs	Shoe trees	Stretch pants	Steering wheels
Jerseys	Rafts	Card tables	Rubber duckies
Fences	Sockets	Warm-up suits	Golf-cart bodies
Pillows	Flippers	Weed killers	Ping-pong paddles
Checkers	Tiles	Football pads	Mattress covers
Syringes	Wallets	Carbon paper	Crabgrass killer
Shoes	Backpacks	Dishdrainers	Carpet sweepers
Mascara	Mailboxes	Hearing aids	Refrigerator linings
Sweaters	Uniforms	Track shoes	Wall coverings
Aspirin	Pacifiers	Pond liners	Acrylic paints
Ink	Cassettes	Protractors	Vacuum bottles
Hair spray	Dominoes	Clothesline	Bearing grease
Food wraps	Luggage	Chess boards	Air conditioners
Seed tape	Antifreeze	Slip covers	Rubbing alcohol
Slips	Shorts	Patio screens	Flashlights
Purses	Decoys	Exercise mats	Motorcycle helmets
Puzzles	Pencils	No-wax floors	Sugar bowls
Puppets	Model cars	Lighter fluid	Darkroom trays
Pajamas	Dolls	Attache cases	Tobacco pouches
Upholstery	Antenna cable	Epoxy paint	Garden hoses
Racks	Credit cards	Oil filters	Lawn sprinklers
Dresses	Heart valves	Welcome mats	
Earphones	Antiseptics	Flashlights	
Whistles	Vinyl siding	Antibiotics	
Yardsticks	Safety flares	Shower doors	

Adapted from An Energy History of the United States, U.S. Department of Energy, 1978.

1-4. Views from other countries

The energy issue is more than just a U.S. problem; it affects the rest of the world's nations as well. The energy practices and policies of the U.S., as the world's largest energy consumer, affect and are affected by nations outside our borders. Each nation has its own perspective on the energy situation, and they, like the experts, do not all agree on the nature or implications of the current energy situation. Since the nations of the world are becoming ever more interdependent upon each other, it is important for us to be at least aware of the differing views of our world neighbors.

Activity:

Read the brief sampling of the views of different nations in Appendix II, p. 107. You may wish to explore further the readings suggested in the chapter references.

Questions for discussion:

1) How do other nations see the energy situation? How are their assessments like or unlike that of the U.S.?
2) How do other nations view the role of the U.S. in the energy problem and its solutions? Do you think any of these views are justified? Why or why not?

1-5. Energy data

Energy is an issue that affects our daily lives and will probably become more important in the future, as oil and natural gas become more expensive to obtain. It is an issue that the U.S. will have to face, but beyond that, it is a global issue that affects all nations.

We have sampled the opinions of experts, surveyed our own opinions on energy and those of other nations, and noted our dependence on it. In order to put the energy issue into a global context, let's look at some basic statistics as presented in figures 2-10 on the following pages.

We will study the implications of these charts more carefully as we go through this case study, but try to draw some preliminary conclusions from this data in a class discussion.

Questions for discussion:

1) Which energy sources are supplying an increasing share of the energy used? Recalling the reading of experts' opinions, which energy sources are likely to be problematic in the future? Which energy sources are being used less? What problems of adjustment would be involved if we increasingly returned to these sources for energy?
2) Where are the world's major energy resources located (for fossil fuels)? Remember that these are estimates based on geological surveys and on prevailing prices. Where the surveys are detailed, as in the industrialized

countries, the estimates are closer, but where they are scattered or information is not available, the estimates are very rough. The estimates also indicate how much oil can be profitably produced at the prevailing price. If the price goes up, more costly sources of oil could be tapped.

3) Which nations produce the largest share of oil? Which nations consume the largest share of oil? What problems might be faced by those oil-consuming nations which do not produce oil?

4) How has world energy use changed over the years?

5) What share of the world's oil does the U.S. consume? How does this compare with its share of the world's population?

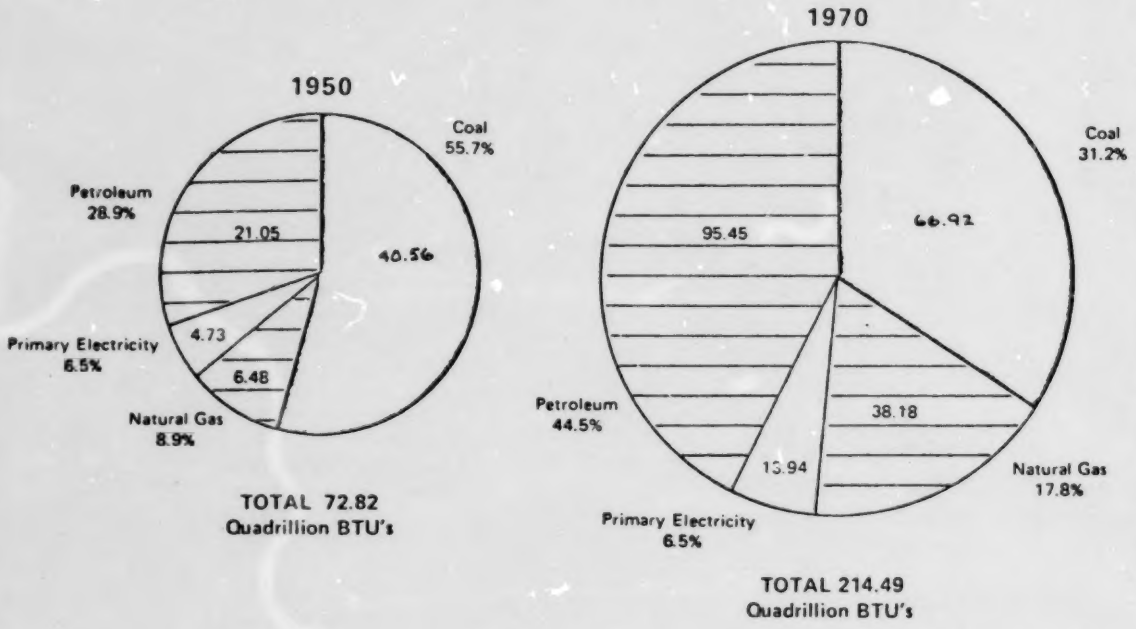
6) From what nations did the U.S. import oil in 1974?

7) Are there oil-exporting nations which are not Arab countries? which are not members of OPEC? Are there Arab countries that do not export oil?

1-6. Chapter 1: summary questions

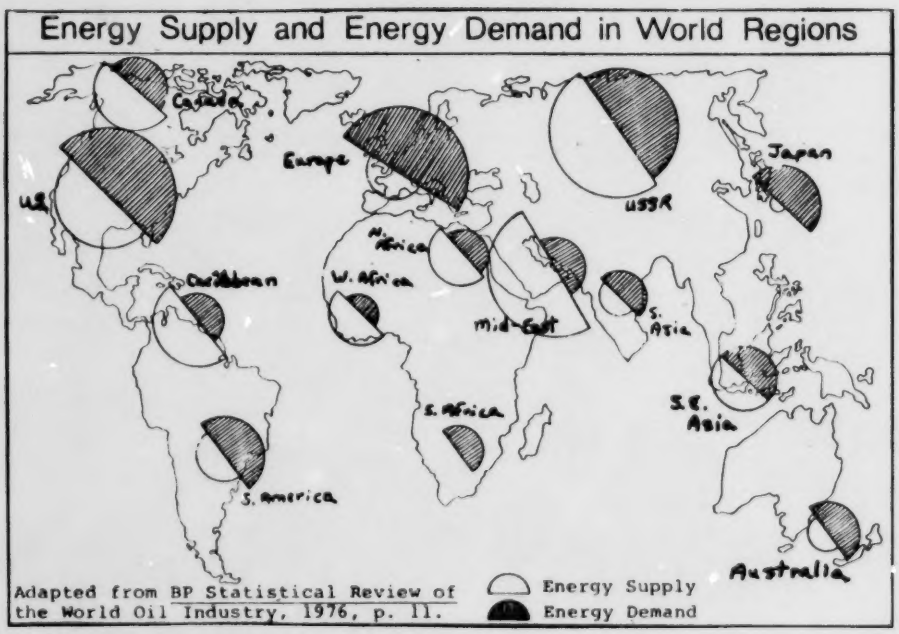
1) Is there an energy problem?
2) Whose problem is it?
3) Why is energy a global issue?
4) How does it affect us?

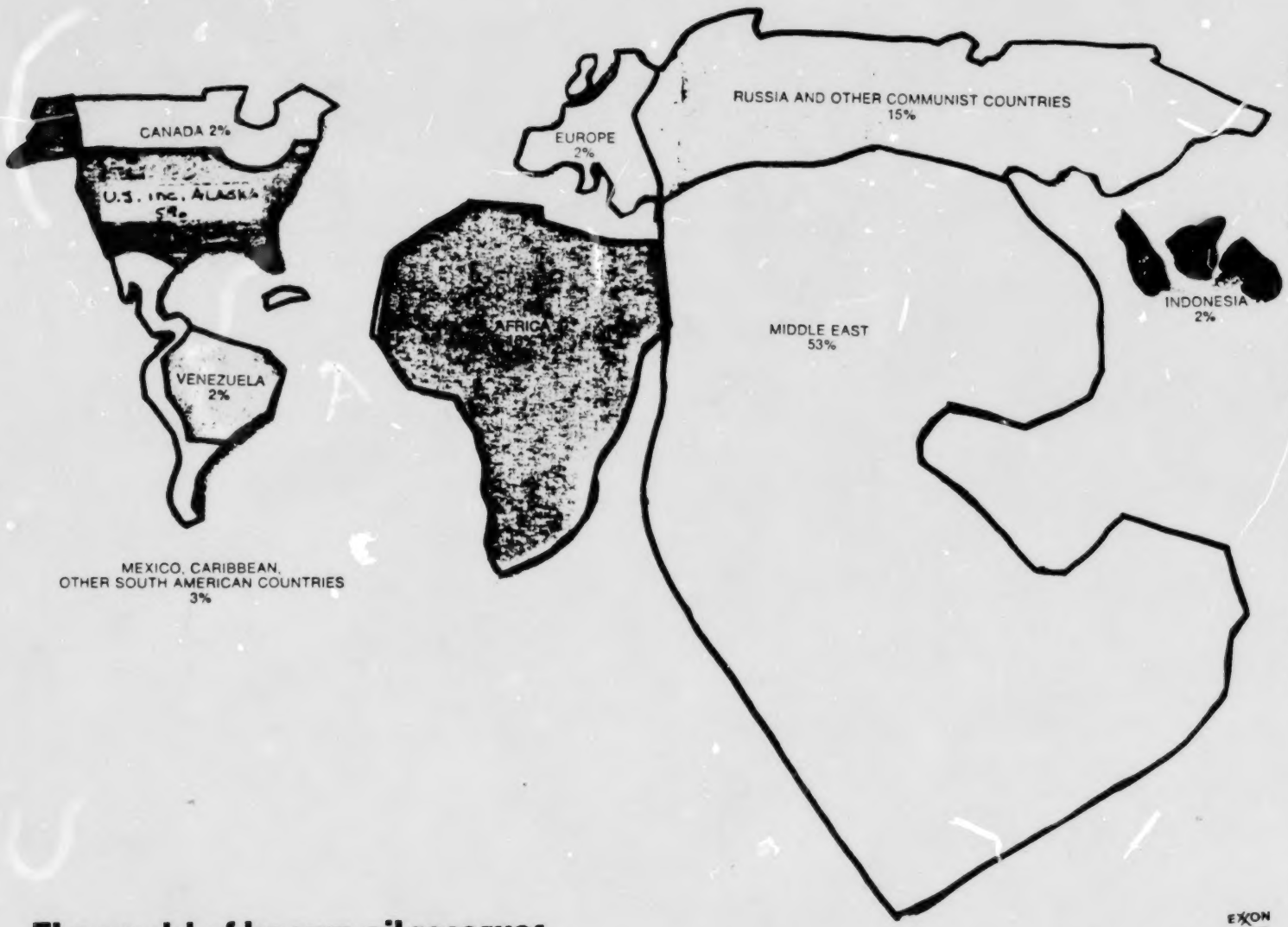
Figure 2: SOURCES OF WORLD ENERGY SUPPLY
1950 and 1970



SOURCES: Overseas Development Council, *The U.S. and the Developing World: Agenda for Action 1974.*
Energy Policy Project of the Ford Foundation, *Exploring Energy Choices.*

Figure 3:





The world of known oil reserves.

Percentages are shares of the world's known, extractable oil reserves in each area.

SOURCE *Oil & Gas Journal*—December 25, 1972

Figure 4: Proportional Map of World Oil Reserves

Figure 5:
Proportional Map of
World Coal Reserves

source: Exxon Corporation

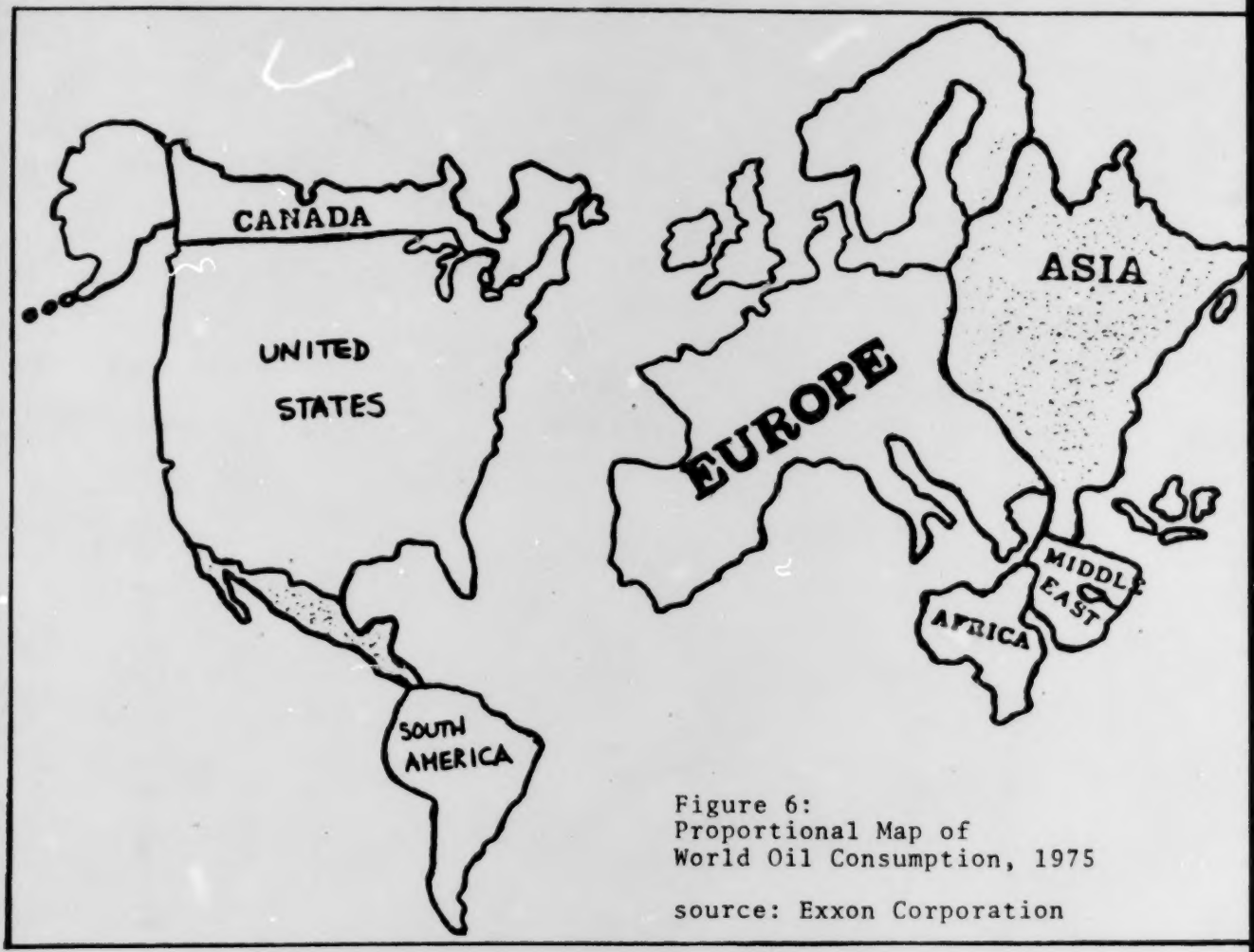
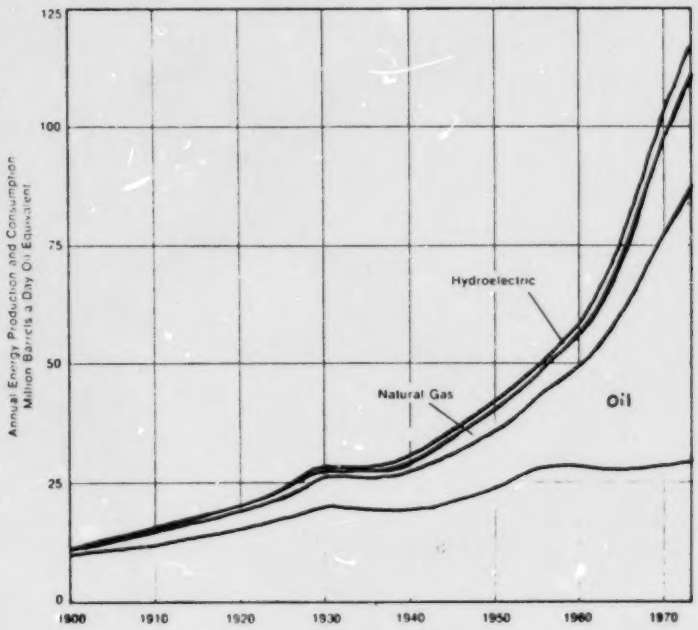


Figure 6:
Proportional Map of
World Oil Consumption, 1975

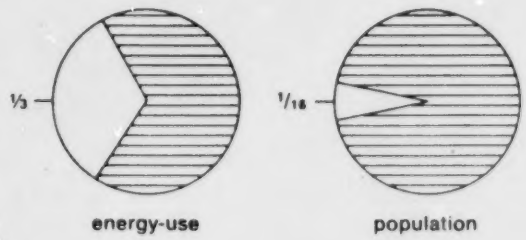
source: Exxon Corporation

Figure 7:
Energy Production
and Consumption
of the World



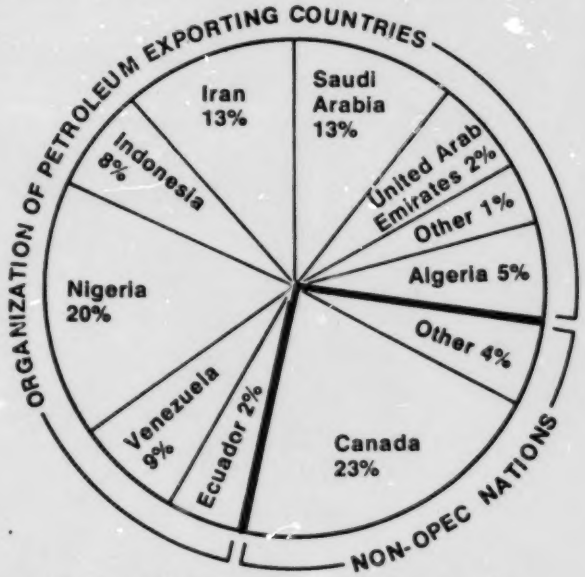
from: Energy: Global Prospects 1985-2000, Workshop on Alternative Energy Strategies, 1977, p. 17.

Figure 8:
U.S. Share of Energy Use
and of Population



from: Your Energy World, U.S. Department of Energy, February 1978.

Figure 9:
U.S. Oil Imports, 1974



From: The Energy Challenge, Federal Energy Administration, Activity Master 22.

Figure 10: Members of the Organization of Petroleum Exporting Nations (OPEC)

Algeria	Iraq	Saudi Arabia
Ecuador	Kuwait	United Arab Emirates:
Gabon	Libya	Abu Dhabi
Indonesia	Nigeria	Dubai
Iran	Quatar	Sharjiah
		Venezuela

Chapter 1. References and suggestions for further reading. [Note: Full citations and ordering addresses can be found in the Bibliography.]

1-1. Opinion survey

Global Development Studies Institute. The Local Community and Global Awareness. A guide to using surveys of the local community to point out its interdependence with the larger world.

National Assessment of Educational Progress. Energy: Knowledge and Attitudes--A National Assessment of Energy Awareness Among Young Adults. Results of the poll show a general lack of information.

United States Department of Energy. Citizen's Workshops on Energy and the Environment Handbook. Energy survey and primer.

1-2. Energy in our lives

Guidance Associates. Global Emergency Series: Energy. Filmstrip on energy.

Massachusetts Audubon Society. Energy Packet. Introductory materials on energy.

National Science Teachers Association, for the U.S. Department of Energy. An Energy History of the United States. Curriculum with student handouts, including list of petrochemical products in figure 1.

Walt Disney Educational Media Company. Mickey Mouse and Goofy Explore Energy. Comic book, but fairly painless introduction to energy basics.

Daniel Yergin. "The Real Meaning of the Energy Crunch." Excellent introduction to energy as a global and political issue.

1-3. Energy crisis?

For organizations and companies that can provide expert views on energy matters, see the "Organizations" listing in the Bibliography.

See Appendix II for citations of articles excerpted there. For other recent articles on the energy crisis, refer to the Reader's Guide to Periodical Literature, under the listings of "Energy" and "Petroleum."

Albert A. Bartlett. "Forgotten Fundamentals of the Energy Crisis." Includes sample expert statements and evaluation of them.

Lester R. Brown. Resource Trends and Population Policy: A Time for Reassessment. Views of a noted globalist and environmentalist.

Jo Anne Buggey and June Tyler. The Energy Crisis: What Are Our Choices? Good commercial textbook with selected short readings from diverse viewpoints.

Foreign Policy Association. Great Decisions '79. For results of 1978 survey on energy policy.

Milton Friedman. "Blaming the Obstetrician." Brief critique of government oil-pricing policies.

Denis Hayes. Rays of Hope: The Transition to a Post-Petroleum World. The solar energy viewpoint.

Lewis H. Lapham. "The Arabian Oil Bubble." Myth of OPEC's omnipotence.

Anthony J. Parisi. "Anatomy of the Gasoline Crisis: Its Origins, Reality and Handling." Balanced and clearly written analysis.

Lon C. Ruedisili and Morris W. Firebaugh, ed. Perspectives on Energy--Issues, Ideas, and Environmental Dilemmas. Good source of expert opinions from diverse viewpoints.

1-4. Views from other countries

See Appendix II for citations of articles and publications excerpted there.

For more information and views from other nations, contact the national embassies in Washington, D.C., or the consulates in other cities. The addresses can be obtained from the appropriate telephone books. [You can request a copy of the Washington, D.C. telephone book from your local telephone company.]

Atlas: World Press Review. April 1977 issue. Views from other countries on the global nuclear power controversy.

Center for Economic and Social Information. Development Forum. Newspaper with articles from international sources.

Don Cook. "How Carter's Nuclear Policy Backfired Abroad." Economic implication of U.S. nuclear policy abroad.

Vivian Lewis. "Europe's Oil Imbroglio." European nations' energy and foreign policies.

The Organisation for Economic Co-operation and Development. The OECD Observer. Views of member countries, mostly Western.

John C. Sawhill, Keichi Oshima and Hanns W. Maull. Energy: Managing the Transition. Analysis of the energy policies of the U.S., Europe, Japan and Canada.

1-5. Energy data

Energy Policy Project of the Ford Foundation. A Time to Choose--America's Energy Future. The final report of the Project includes a chapter on "U.S. energy policy in the world context."

Exxon Corporation, Public Affairs Department. Source of proportional maps for figures 4-6.

Federal Energy Administration. The Energy Challenge. Activity masters with graphs, including the one used in figure 9.

Duncan Gibson, Ed. World Eagle. Source of data for social studies, some on energy.

Hammond Map Company. For maps and atlases.

John McHale. World Facts and Trends. Good global data and graphs on energy and other topics.

John W. Sewell and the staff of the Overseas Development Council. The United States and World Development--Agenda 1977. For reading about energy as a global issue.

H.C. Truran. A Practical Guide to Statistical Maps and Diagrams. For further map and statistics skills work.

U.S. Department of Energy. Energy in Focus--Basic Data. U.S. statistics.

_____. Your Energy World. Activity masters with graphs, including that in figure 8.

U.S. Department of State. The United States and World Energy. Facts and data on energy and U.S. foreign policy.

World Bank. World Atlas of the Child. Good, free atlas with basic social and economic data on the world's nations.

Workshop on Alternative Energy Strategies. Energy: Global Prospects 1985-2000. Authoritative projection of the world's future energy needs and supplies; source of graph in figure 7.

CHAPTER 2. WHAT IS ENERGY?

We have reviewed some of the current opinions, predictions and statistics on the energy issue, in order to gain an idea of its importance in our lives and in the world's future. Before digging any deeper into the environmental, political, economic or social aspects of world energy production and use, we should first go over the scientific definitions and concepts about energy. This chapter will provide a brief overview of the basic scientific laws that apply to energy use and the basic vocabulary of terms used to describe energy. It includes a survey of energy use in your school and homes, so that you can understand the concepts introduced in this chapter in the context of daily energy use.

2-1. Forms of energy

Energy is the ability to cause change, and it is measured by the effect it has on matter.

There are several major forms of energy--mechanical, chemical, electrical, nuclear, light and heat--and energy can change from one form to another. For example, in a hydroelectric generating station, the mechanical energy of falling water turns the blades of a turbine generator and is transformed into electrical energy. Or, in an example of biological energy use, the chemical energy in the food we eat is transformed in the cells in our bodies into heat or into the chemical and mechanical energy needed to walk, think, or move our eyes across this page.

Energy in its different forms comes from a variety of sources. Most of these, with the exception of nuclear energy, can be traced back to the sun in one way or another. For example, the electricity which runs a television set may come from a generating station which burns coal. The coal was formed from the remains of plants which absorbed light from the sun in the prehistoric past. The sun's own energy comes from the nuclear fusion reaction that occurs continuously within it on an immense scale.

Questions for discussion:

1) List twenty ways energy causes change, and for each indicate the form or forms of energy involved. What kind of changes occur, for example, when energy is involved in

toasting bread? running a car? Every change involves energy in some form. How can changes be productive or destructive?
2) As a class, list as many energy sources as you can, and trace them back to the sun (or to nuclear energy sources). How might this exercise make more understandable the sun worship common to many cultures?
3) Because there are different forms of energy, there are a number of ways to measure its effect on matter. We have listed, in figure 11, some of the most commonly used units of measurement and their equivalents. What different effects of energy do the different units measure?

Figure 11: Units of Measurement and Equivalents

1 Calorie = energy necessary to raise the temperature of 1 liter of water by 1° Centigrade
1 British Thermal Unit (BTU) = energy necessary to raise the temperature of 1 pound of water by 1° Fahrenheit
1 kilowatt-hour = 1000 watts running for 1 hour or 1 watt running for 1000 hours

Equivalents:
1 Calorie = 4.0 British Thermal Units (BTUs)
1 kilowatt-hour = 860 Calories
1 kilowatt-hour = 3400 BTUs

2-2. Energy use survey

Begin an energy use survey of your home. First list the sources of energy (gas, oil, electricity, wood, solar, gasoline, etc.) and their uses (gas for cooking, oil for heating, gasoline for transportation, etc.) Try to be as complete as possible.

The next step is obtaining figures on how much energy is used. You will probably have to ask your parents or landlord for information from their utility bills. It is important to explain to them that we are simply trying to get an idea of approximately how much energy is used in a household, not to compare bills or judge them critically. Your teacher may bring in his or her own utility bills, to show how to get the information you need. In addition to looking at utility bills, try to obtain information on the average monthly amount of energy used from other sources, particularly gallons of gasoline, amount of wood in fireplaces or stoves, etc.

Ask your school administrators for information for an energy use survey of the school. Find out from the local electric

company how and where most of the electricity in your area is generated. You may also be able to obtain from them an energy use survey of your community to estimate or compare with your energy use figures.

2-3. Thermodynamics

Energy use is governed by the laws of thermodynamics (from the Greek, thermo=heat, dynamics=power). The first and second laws of thermodynamics are as follows:

1. In all chemical and physical changes, energy is neither created nor destroyed, but merely changes form.
2. In any change, the amount of disorder increases, and some energy is converted to its least useful form, heat.

The first law of thermodynamics says, in essence, energy comes from somewhere and goes to somewhere. At the end of a chemical reaction or a physical event, there is as much energy as there was at the start--it is simply in different forms. Nuclear energy is the exception to this rule, because in nuclear reactions or explosions, large amounts of energy are created from very, very small amounts of atomic matter. (It is this process that is described in the equation $E=mc^2$, or "the amount of energy created is equal to the amount of matter lost multiplied by the square of the speed of light.")

If energy cannot be destroyed, why is there a global energy problem? This is explained by the second law, which indicates the general trend of all energy transformations. At the end of any change, because all changes involve energy, there is as much energy as at the start, but less of it is in a usable form. Some of the energy is converted into heat or motion that spreads over a wider and wider range until it is imperceptible and no longer usable. It is the transformation of energy to more dispersed and disorderly and less usable forms that is meant when people say energy is "lost" in a process. The loss of energy could be compared to the overnight loss of water in a shallow pan. The water has not really been lost or destroyed, but has merely evaporated; instead of being concentrated in the pan, it is now dispersed throughout the air in the room.

We will explore some other situations that illustrate the tendency toward disorder of all changes.

Activities:

1) Shuffle a deck of cards that has been ordered by suit and number. Observe. Shuffle several times more and observe. Compare this with the first shot in a pool game or the first ball thrown in bowling. How has disorder increased? How many energy inputs, i.e. shuffles, shots or balls thrown, are required to disrupt the order of the cards, pool balls or bowling pins? How does the amount of energy necessary to reestablish the original order compare to the

amount that was required to disturb the order?
2) Drop a small amount of food coloring into a glass of water. Describe the results. What would be necessary to reconcentrate the food coloring? How about if two colors were mixed? How did you use energy to cause changes in these experiments? How does the amount of energy needed to bring about disorder compare with the amount of energy necessary to restore the original orderly situation? What are the possible implications for the problem of cleaning up air or water pollution?
3) Compare two photographs, either:
a) one of an area of natural vegetation and one of plowed fields of crops, or
b) one of the original appearance of a structure and one of the same structure after a period of abandonment.
How is energy involved in keeping the fields or the structure orderly? What happens when this investment is stopped? Where does the energy come from that brings about the changes from orderly fields or buildings to disorderly ones?

Another word for the increased disorder, or the decreased concentration and complexity, that occured in these experiments is entropy. The transformation of more concentrated energy into heat means increased entropy or disorder. In any change, entropy increases.

Question for discussion:
The laws of thermodynamics have also been rephrased thus:
1. You can't win.
2. You can't even break even.
Explain what these statements mean in terms of energy use and entropy.

2-4. Energy transformations

We have introduced the laws of thermodynamics in very general terms; let's turn now to a more specific example of energy transformation.

Classroom activity:
Compare the amount of heat, in calories, absorbed by water from an electric hot plate with the caloric value of the electricity used. You will need a hot plate, a beaker or other heatable container and a laboratory thermometer. Place a measured amount of water at room temperature in a heatable container on the hot plate. Put the thermometer in the water and record the starting temperature. Turn on the hot plate, and record the water temperature every minute for 6 minutes (1/10 of an hour). Turn off the hot plate and continue recording the temperature at regular intervals.

Subtract room temperature (in degrees Centigrade) from the ending temperature, and multiply this figure by the volume of water in milliliters. (See conversion table below, if necessary.) This is the caloric value of the heat absorbed by the water. Multiply the power rating of the hot plate (in watts) by the time of operation (in hours). Multiply the number of watt-hours by a conversion factor of 860 to obtain the caloric value of the energy used in operating the hot plate.

Figure 12: Conversion to Metric Units

a) 1 cup = 237 milliliters

b) To convert from Fahrenheit degrees to Centigrade degrees: Subtract 32 degrees from the Fahrenheit number and multiply by 5. Divide the result by 9 to obtain the Centigrade equivalent. In other words:

$$\frac{(°F - 32) \times 5}{9} = °C$$

Questions for discussion:

1) How does the caloric value of energy used compare with the caloric value of heat absorbed? Where did the calories go that were not absorbed by the water or that were lost when the water cooled back down to room temperature?

2) How did this experiment follow the laws of thermodynamics?

Optional activity:

This experiment involved accounting for the heat lost from a heating device: a hot plate. If possible, set up with the help of a science teacher further experiments to measure the heat produced by an air conditioner, refrigerator, or light bulb. How much energy ends up in the form of heat lost to the environment from appliances that perform chores other than heating?

2-5. Energy quality

Fuel is a form of matter that contains energy concentrated enough to have relatively high power when it is released. Power is the rate at which energy is used during a process. The power of the energy released determines the energy quality of the fuel. For example, natural gas is a high quality fuel, because it can release a large amount of energy in a short time to produce a very high heat.

Questions for discussion:

Compare the amount of energy available in equal quanitites of coal, wood, oil and uranium ore, as shown in figure 13. How do the fuels compare in energy quality? Why is uranium such a high quality fuel?

Figure 13: Energy in Equal Units of Fuel

1 gram wood	= 0.0018 kwh	= power to light 1 hundred-watt bulb for 1 minute
1 gram coal	= 0.0037 kwh	= power to light 1 hundred-watt bulb for 2 minutes
1 gram alcohol	= 0.0064 kwh	= power to light 1 hundred-watt bulb for 3 1/2 min.
1 gram gasoline	= 0.0128 kwh	= power to light 1 hundred-watt bulb for 7 minutes
1 gram Uranium-235 (fission reactor fuel)	= 20,000 kwh	= power to light a small town (60,000 inhabitants) for 1 hour
1 gram Deuterium (fusion reactor fuel)	= 150,000 kwh	= power to light a large city (500,000 inhabitants) for 1 hour

from: The Unesco Courier, UNESCO, June 1978, p. 7.

Activity:

Calculate the total amount of energy used per month in your school and home. Express this amount in BTUs or some other common unit of energy. What are the equivalent amounts of coal, wood or oil? How much energy is used per person? If possible, keep records for several months or compare with past records, to determine how consumption varies in amount and type from season to season.

2-6. Net energy

The BTU content of the fuels listed in figure 14 is the gross energy of a fuel, that is, the total energy content of a fuel before any of it is lost in obtaining it, transporting it or converting it to usable form. Figure 15 shows the percentage of gross energy that must be invested in the processing, i.e. mining, refining and transporting, of four major fuels.

Figure 14: Energy Content of Common Units of Fuel

Electricity	- 1 kilowatt-hour (kwh)	= 3,400 BTUs
Wood	- 1 cord (128 cubic feet)	= 20,000,000 BTUs
Coal	- 1 pound	= 12.000 BTUs
Fuel oil	- 1 gallon	= 140,000 BTUs
Gasoline	- 1 gallon	= 125,000 BTUs
Natural gas	- 1 cubic foot	= 1,021 BTUs

Figure 15: Energy Investments Necessary to Obtain Fuel

Fuel	% of Total BTUs Consumed	Activity
Coal	4%	To produce
	3%	To transport
	67%	To generate electricity
	15%	To transmit electricity
Natural gas	4%	To produce
	3%	To transport
Fuel oil	4%	To produce crude oil
	10%	To refine fuel oil
	3%	To transport fuel oil
Gasoline	4%	To produce crude oil
	13%	To refine gasoline
	3%	To transport gasoline

from: Energy, Food and You, Washington State Office of Public Instruction, 1977, p. 73.

Energy is also lost to less useful forms when converted from one form to another. Figure 15 indicates the conversion losses involved when coal is used to produce electricity. When any fuel is burned to produce electricity by heating steam to drive the turbine generators, about 67% of that fuel's energy is consumed in its conversion to electricity. In nuclear plants, which use the heat produced in controlled nuclear reactions to

drive steam turbines, efficiency is slightly lower--about 70% of the heat value is lost.

When electricity is transmitted from the generating station to the consumer, another 10% of the energy content is lost.

Activity:

Calculate the net energy obtained from the fuels listed in figure 13,using the gross energy values listed in figure 14. For example, the gross energy content of one gallon of gasoline is 125,000 BTUs. 20% of that, or 25,000 BTUs, is consumed in production, refining and transportation. The net energy is thus 100,000 BTUs.

Questions for discussion:

Which fuels are more efficient? How does the conversion of a fuel to electricity compare with the direct use of that fuel? Why might direct use not always be practical, as in trying to light your house with coal? The choice of energy sources depends not only on efficiency but also on availability, cost and environmental effects. We will explore these other aspects of energy use in later chapters.

2-7. End-use efficiency

In 2-6, we calculated the net energy that remains when a fuel or electricity arrives at its destination. This is not the end of the story, however, because different energy sources perform different tasks, or else perform similar tasks with different efficiencies. For example, an electric heating system for a house is nearly 100% efficient--nearly all the energy is used in heating the air and little is wasted. In a gas or oil heating system, efficiency is closer to 60%--about 40% of the fuel energy is lost in incomplete combustion, etc.

Activity:

Calculate the overall efficiencies of 1) an electric heating system from oil-generated electricity, and 2) a heating system that burns fuel oil. How do they compare?

End-use efficiency can be increased by matching energy quality of a fuel with the power and type of energy required for the job. The use of a blow-torch to light a cigarette, for example, would not only be dangerous but wasteful, because most of the high-temperature heat would not be used. The lower-quality heat of a single match would be sufficient for the job.

While space heating does not usually require the high quality energy available from electricity, jobs such as lighting, operating appliances and driving small motors usually do. Even here, however, efficiency can vary depending on the appliance and the job that needs to be done. Heating or cooling, as in toasters or refrigerators, requires more energy and wastes more in lost

heat than the mechanical energy needed for small motors, as in an electric clock.

Questions for discussion:

1) Using figure 16, how do various household appliances compare in energy required? How much water at 30° C (warm bath temperature) is equivalent in Calories to 1 kilowatt-hour of electricity? (Refer to figure 11 for energy units and equivalents.) How is the energy quality of these two sources of energy different? How are they both different from their Calorie equivalent in food energy of a Big Mac and a milkshake? Which would be more useful for lighting a lightbulb? What jobs require high quality energy? lower quality energy?

Figure 16: Electrical Usage of Common Appliances

Item	Average kwh per month
Dishwasher	35
Microwave oven	16
Electric range	98
Blender	1
Can opener	1
Electric clock	1
Automatic coffeemaker	8
Toaster	3
Slow cooker	12
Refrigerator	152
Vacuum cleaner	4
Clothes washer	9
Clothes dryer	80
Space heater	75
Water heater	400
Color TV	55
Black & white TV	30
Radio-record player	9
Power saw	4
Electric blanket	12
Hair dryer	10
Electric toothbrush	1
Room air conditioner	72
Electric fan	12
Electric furnace	1100
Yard light	30
Garage door opener	1

from: Your Energy World, U.S. Department of Energy, 1978, Unit One, Activity Master #3

2) Obtain the efficiency rating for the hot plate you used in the experiment in 2-4, by dividing the caloric value of the heat absorbed by the caloric value of the electricity used. How could the efficiency rating be improved? How would the efficiency of the electric hot plate compare with the efficiency of using a blow torch to heat the water? a series of lighted matches? How can too much or too little power decrease energy efficiency?
3) With each step or change from raw fuel to its end use, energy is lost. Trace the "energy history" of the heat from the hot plate back to its source. How was energy reduced at each step? How does this illustrate the second law of thermodynamics?

Optional activity:
Using figure 16, plus any other information you can obtain, make an appliance survey of your home, and estimate the average monthly energy used by each in kilowatt hours.

2-8. Chapter 2: summary questions

1) Define energy and list its major forms.
2) What are the laws of thermodynamics? What is entropy? Why is it significant in the study of energy?
3) How do the concepts of energy quality and efficiency relate to energy use? Why does the gross energy content of a fuel differ from its net energy?
4) What are the major sources of energy in your school? in your home? What is the average monthly total of energy used?

Chapter 2. References and suggestions for further reading.

Antioch Community Schools District. Environmental Education: Values for the Future. Suggestions for more science activities, particularly in the area of thermodynamics.

Center for Teaching International Relations. Teaching About Energy Awareness: 33 Activities. Suggestions for more activies, including an energy awareness quiz and a survey of household appliances.

Massachusetts Audubon Society. Energy Packet. Basic science information in the articles of The Curious Naturalist which are part of this packet.

Lon C. Ruedisili and Morris W. Firebaugh, ed. Perspectives on Energy--Issues, Ideas and Environmental Dilemmas. More advanced articles on some of the scientific aspects of energy.

Staples Energy Conservation Program. Staples Energy Conservation Program. A packet of lesson outlines, including surveys of

energy use and electrical costs, and discussions of the definition, forms and conversion of energy.

H. Stephen Stoker, Spencer L. Seager, and Robert L. Capener. Energy from Source to Use. College text reviews the nature, forms, conversion and utilization of energy.

Mark Terry and Paul Witt. Energy Order. High school teaching sequence which develops basic energy vocabulary and concepts, particularly thermodynamics and energy relationships of systems.

United Nations Educational, Scientific and Cultural Organization. The Unesco Courier. The June 1978 issue on energy alternatives contains the data used in figure 13.

U.S. Department of Energy. Your Energy World. Activity masters with basic data, including the data for figure 16.

Washington State Office of Public Instruction. Energy, Food, and You. Includes lessons and activities on the basic characteristics of energy, entropy and conversion losses. Source of data for figure 15.

CHAPTER 3. WHY IS THERE AN ENERGY PROBLEM?

We now have a clearer idea of what energy is and how it works, but how did it get to be a global problem? The current energy situation has been developing for at least 100 years; it is not simply a matter of Arabs raising oil prices. In order to know the future of the world energy situation, we must know more about its past.

3-1. Renewable resources

Energy use in our time is very different from energy use of 200 years ago or even 100 years ago, and a notable feature of the shift in energy sources has been the shift from renewable to nonrenewable fuels. Renewable resources are fuels which can be replaced in a relatively short time; nonrenewable resources like oil and coal are essentially irreplaceable, because they require many thousands of years for their formation.

Activities:

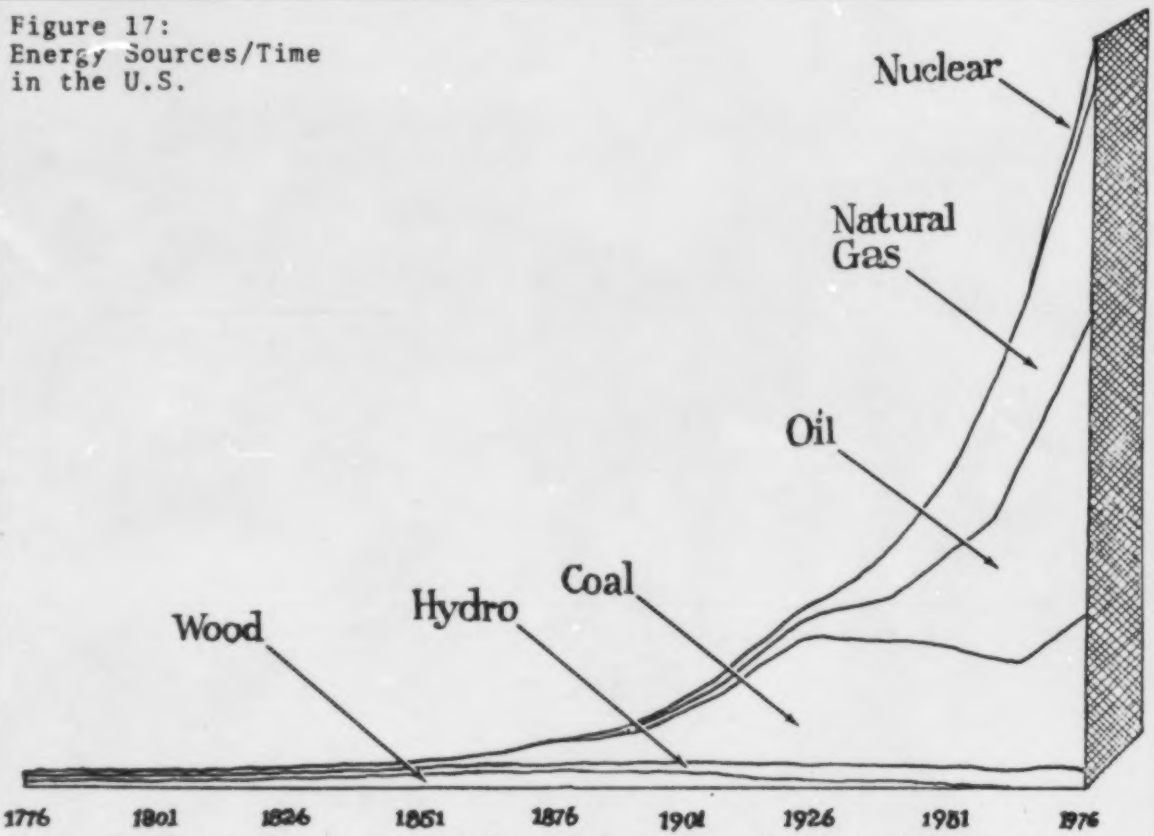
1) List the major energy sources of 1780 and of 1880. (See figure 17, page 28, for a graph of energy sources/time in the U.S.) What regions or nations do they come from?

2) Assume you have a plot of land with approximately 1,000 trees and an oil well over a formation from which a total of about 1,000 barrels of oil could be extracted. If the trees take an average of 25 years to mature, what is the optimum number of trees that can be harvested each year? What would happen if you cut down more trees? How does replacement time limit your harvest? How much oil can you produce each year? For how many years? What is the ultimate limit of your oil production? If you compare the maximum potential energy yield (in BTUs) for each resource, you will note that the comparison is between a limited amount and an unlimited amount. Make a graph of oil production and wood production from the plot of land.

3-2. Energy demand

Look again at figure 17, and note the sharpness of the increase in energy use. Let's explore the reasons for this increase. The price of oil in dollars per barrel was about $1.80 between

Figure 17:
Energy Sources/Time
in the U.S.



from: So What's New?, Energy Research and Development Administration, 1975, p. 10.

1960 and 1970, as compared to the 1975 price of $11.25. What is the current cost of oil per barrel? From 1960 to 1970, the cost of oil, a high quality fuel, was relatively low in comparison to other sources of energy, such as wood or coal, even allowing for some inflation in prices. This was an important factor in the shift from renewable resources to fossil fuels.

Another factor was the increased use of internal combustion engines which burn fossil fuels. The transportation sector of the economy (cars, trucks, diesel trains and airplanes) has been responsible for a large part of the demand for oil. In 1977, transportation accounted for 60% of the oil used in the United States.

While fossil fuels were relatively inexpensive, energy was cheap and available. This meant that considerations such as convenience, speed and comfort were more important than the amount of energy used. People in the industrialized countries became more and more accustomed to the lifestyle possible with a high rate of energy use. For example--each family wanted a car, and later each

adult member of the family wanted his or her own car. Electrical appliances, like washing machines and televisions, which ease work or provide amusement started to be regarded as necessary in a modern household.

Inexpensive energy also meant that large energy losses in processing, packaging, and distributing foods and other items could be tolerated. Thus, products purchased by consumers had more and more energy "invested" in them. For example, between the potato and the McDonald's french fry is a whole sequence of activities from harvesting and shipping to cutting, freezing, frying and packaging, not to mention driving a car to the restaurant and back.

The availability of fossil fuels also led to the development of a petrochemical industry, which uses the chemicals in oil, gas, and coal as raw materials in the manufacture of plastics, synthetic rubber and a number of other products. (See figure 1, page 5 , chapter 1, for a list of products.) The new petrochemical products were often developed as synthetic substitutes for natural products that were expensive (silk stockings), required a fair amount of land or labor to produce (cotton), or had to be imported (rubber). Often, as was the case with plastics, new uses and capabilities were found, such as magnetic tapes for recording, or plexiglass for curved windshields.

The growth in energy demand is related to economic growth, particularly in the industrialized nations, over the past century. Economic growth means that a country's farms, factories and businesses produce more crops, manufactured items or services (whether haircuts, concerts or tonsillectomies). Economic growth has been largely fueled by fossil fuel energy. For example, farmers use tractors and petroleum-based fertilizers and pesticides to increase the productivity of their farms. Economic growth has often resulted in a rising standard of living, both by allowing the employment of more people at better salaries and by producing the things and services they want to buy.

The increased use of energy per person and the increase in the number of people using energy has created an increasing demand for energy and, most of all, for nonrenewable fossil fuel energy.

3-3. Exponential growth

Now that we've briefly reviewed some of the reasons for the growth in demand for fossil fuels, let us examine the nature of that growth. [Note: This section is adapted from "Forgotten Fundamentals of the Energy Crisis", Albert A. Bartlett. See Bibliography for full citation.] The graph of energy use in the U.S. (figure 17, p. 28) is an example of a "J-curve." A J-curve is the shape produced when a graph is made of anything that grows at a fixed percent per year, such as energy consumption,

population or inflation. Growth at a fixed percent per year is called exponential growth, and is characterized by a fixed doubling time. You can easily calculate the time (T_2) it will take for a quantity to be doubled by dividing 70 by the percent growth per unit of time (P). In other words, $T_2=70/P$. If, for example, a population grows 2% a year, the population will double in size in 35 years.

Doubling may start out slowly, like the graph in figure 17, but after a few doubling times, the numbers start to soar rapidly. For example, if you started with just one dollar and doubled it daily, you would have $127 at the end of a week ($1+$2+$4+$8+$16 +$32+$64). The amount you receive each day is $1 more than the total of everything you've received up to that day, so that on the eighth day you would receive $128.

Exercises and questions for discussion:

1) Between 1950 and 1973, world oil consumption grew 7% a year. What was the doubling time for this rate of growth? How much larger than the 1950 figure was the 1973 figure for oil consumption? World energy consumption since 1973, when the price of oil quadrupled, has grown about 2% to 3% a year. What is the doubling time for a 2% growth rate? a 3% rate? World population is also growing at 2% a year. Why does this make it likely that energy demand will continue to grow at least 2% a year?

2) A bacterium reproduces by dividing to create two bacteria. If a bacteria strain which divided once a minute is put into a bottle at 11:00 AM, and the bottle is full at 12:00 noon, when was the bottle half full? If you were a bacterium in the bottle when would you realize you were running out of space? (There is no single answer to this question.) Make a table showing the amount of space left in the last minutes of the bottle. If the more farsighted members of your group found three new empty bottles, quadrupling the amount of living space it took the original group one hour to fill, how much longer could the bacteria continue to grow? Exponential growth becomes a problem if resources are limited or not capable of equally rapid growth.

3) If consumption continues to double at a fixed rate, resources must be discovered and used at the same rate. Look at figure 18 for a model of the necessary growth in resources. The unshaded rectangle represents, approximately, the total amount of oil that has been discovered to date; the shaded rectangle shows the amount we must still discover if oil consumption continues to double every ten years, assuming a continued 7% growth rate in oil consumption. How would the graph differ if energy grows 3% a year after 1975? You will notice that the key determinant in this graph is the doubling time for the rate of growth; it is not necessary to have a precise estimate of the resources left to have a good idea of how long they'll last.

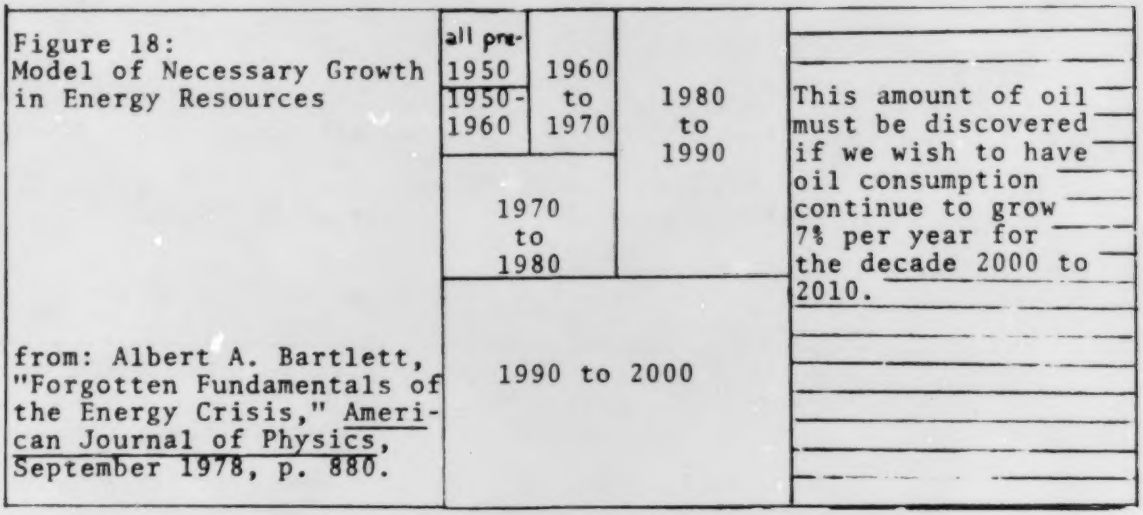

all pre-1950
1950-1960
1960 to 1970
1970 to 1980
1980 to 1990
1990 to 2000
This amount of oil must be discovered if we wish to have oil consumption continue to grow 7% per year for the decade 2000 to 2010.

Figure 18:
Model of Necessary Growth in Energy Resources

from: Albert A. Bartlett, "Forgotten Fundamentals of the Energy Crisis," American Journal of Physics, September 1978, p. 880.

3-4. Fossil fuel demand

We have seen that the worldwide demand for energy is increasing and is likely to continue increasing, and that this increased demand will require substantial increases in energy supplies. There is still plenty of energy in the world--it shines down upon us, blows past us, rushes through streams and rivers, grows in our fields and forests, and lies in ores, deposits and geological formations beneath our feet. The problem is not the total amount of energy available, but the amounts available in the particular forms, such as fossil fuels, which are preferred for their availability, quality, price or convenience. As we discovered earlier, the available amounts of renewable resources are limited by the time required to replace them, but nonrenewable resources are limited by the total amount extractable. And it is the nonrenewable fossil fuels that are supplying a large share of the exponential growth in energy demand.

Exercises and questions for discussion:

1) [Note: this exercise is adapted from The Energy Challenge, Federal Energy Administration, Activity Master #7. See Bibliography for full citation.] Oil and natural gas supply just over 3/4 of the total energy needs of the U.S. Let's calculate approximately how long U.S. reserves of these fuels will last.

a) Many geologists calculate that 65 billion barrels of oil are known to exist in the U.S. and can be extracted by current methods. In 1975, the U.S. produced and used about 3 billion barrels of oil from domestic sources. If these estimated reserves were our only sources of oil, how long would they last at existing production rates? Remember, though, that the U.S. produces only half the oil it uses; the rest must be imported. How long would reserves last if we did not import any oil?

b) It is fairly certain that the U.S. has 442 trillion cubic feet of natural gas. In 1975, about 20 trillion cubic feet were produced and used in the U.S. How long

will this supply last at existing production rates? In addition, a portion of the natural gas we use is supplied by imports.

2) Note that the above exercise was based on "existing production rates" for 1973. It is very unlikely, as we learned in 3-3, that production will not increase to meet increasing consumption rates.

a) How long will reserves last if production rates increase by 2% a year? by 5% a year? What happens in the meantime to the amount of oil the U.S. imports? If we wished to hold imports to current levels, the U.S. would have to increase domestic production by twice the rate of increase in consumption. How long would reserves last at this rate?

b) Collect advertisements, articles or annual reports from the government and the utility companies, and examine their estimates. How many are based on the assumption, explicitly stated or merely implied, of existing or current rates of production? How do the estimates based on zero growth differ from those based on the exponential growth that actually occurs?

3) The U.S. currently uses about 30% of the world's oil produced each year, but it now accounts for 15% of world production. What might be the impact on the world oil situation if the U.S. production were to drop off sharply?

4) Although widespread public awareness that oil is running out is fairly recent, this fact has been foreseen for some time by those who have examined the situation. One of the earliest to point out the ultimate effects of increasing demand for nonrenewable fuels was M. King Hubbert. If production of a limited resource rises to meet rapidly rising demands, it must eventually begin to decline as it begins to be more difficult to extract. Examine figure 19. This graph of oil production has been called "Hubbert's pimple." What does it mean? Why can the 20th century be called the Fossil Fuel Age? What might the 21st century be called? How would the graph be changed: if the increase in demand were reduced? if it leveled off to a constant amount? if new discoveries are made, or ways are found to make existing wells produce more?

5) What do you think will happen to the price of oil if the demand for it is larger than the amount being produced?

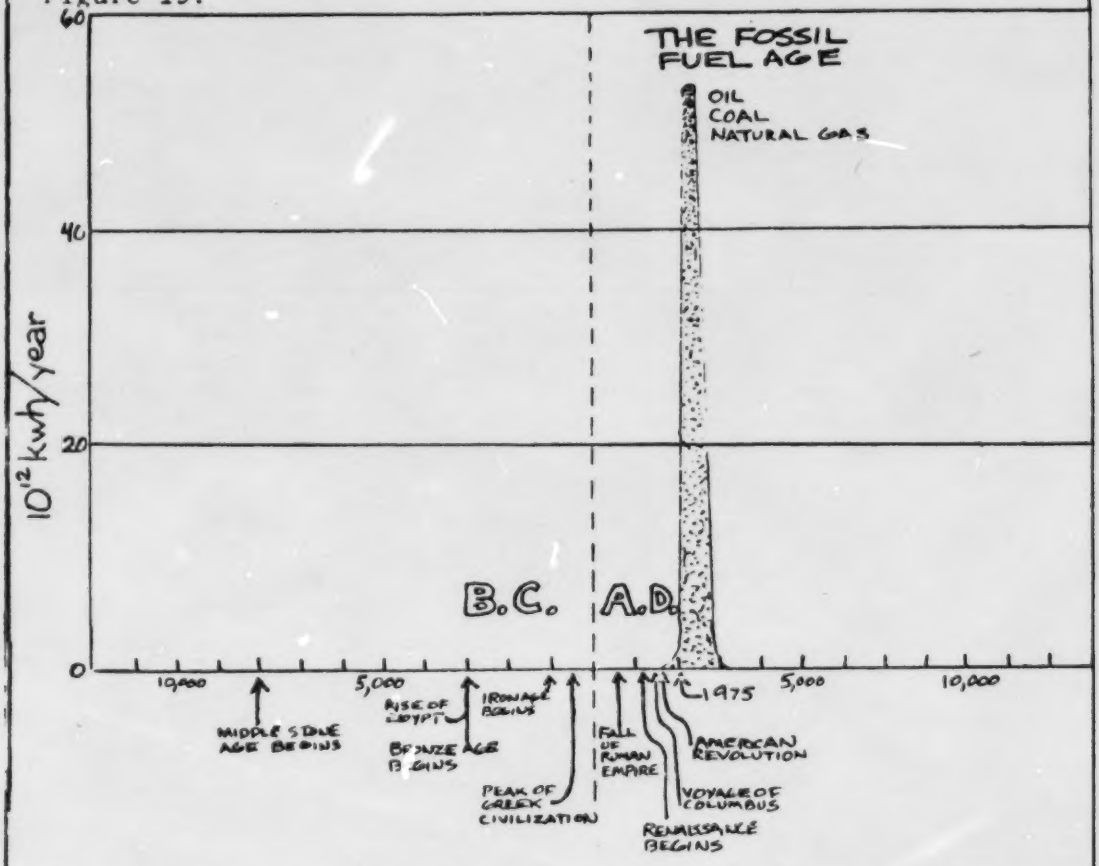
3-5. Fuel supplies

The location of supplies can also pose problems, because the countries which use large amounts of energy are not always the ones with large energy reserves (and vice versa).

Reexamine the proportional maps of world oil and coal reserves and of world oil consumption. Which countries have uranium reserves for nuclear energy? (See figure 20.)

Remember that these are based on estimates of the amounts

Figure 19:



from: Energy, Food and You, Washington State Office of Public Instruction, 1977, p. 108.

Figure 20:
Uranium World Production and Reserves (short tons)

	Production		Reserves
	1975	1976 *	(@ $30 per lb)
United States	11,600	13,500	640,000
Australia	—	500	430,000
Canada	4,631	7,600	225,000
France	2,228	2,200	71,000
Gabon	1,209	1,200	26,000
Niger	1,820	2,000	65,000
South Africa, Republic of and Territory of South-West Africa	3,096	3,200	359,000
Sweden	—	—	390,000
Other Market Economy Countries	450	450	243,000
Central Economy Countries	NA	NA	Moderate
World Total	§25,034	§30,650	2,400,000

* Estimate.
§ Excludes centrally-planned-economy countries.
NA Not Available.
Source: Commodity Data Summaries 1977, U.S. Department of the Interior, p. 183.

from: The United States and World Energy, U.S. Department of State, 1977, p. 27.

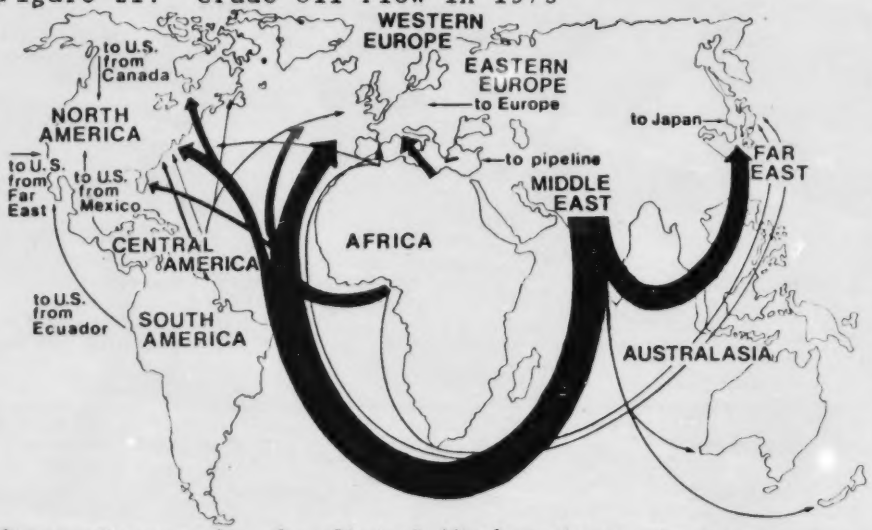
available. Methods of estimating oil, gas and coal reserves have improved over the years, but are not yet completely accurate. Where there has been no exploratory drilling, or where results of drilling are kept secret, as in the Siberian region of Russia or in China, it is difficult even to estimate the potential resources. Since fossil fuels must be mined or drilled at some expense, the words "reserves" and "resources" usually have differing meanings. Resources are the total amount of fuel located in a deposit area. Reserves are the amount that can be drilled or mined at the current fuel prices, without losing money. The amount of reserves that can be produced from an area will vary, depending on the price of fuel (which determines how much can be spent to produce a certain amount), and on the technology available. For example, if cheaper means can be found to force oil out of the ground, more oil can be extracted for the same cost.

Thus the specific location and amount of fossil fuel reserves may vary, (it appears, for example, that Mexico has much larger reserves than previously foreseen) but their nonrenewable nature and the unevenness of their distribution across the world will not change.

Questions for discussion:

1) Examine the oil flow chart in figure 21. How can nations with large energy supplies exercise large amounts of political power?

Figure 21: Crude Oil Flow in 1975



from: Energy in the Global Marketplace, National Science Teachers Association, March 1978, p. 45.

2) List some possible reasons why countries might want to limit the production and export of their energy resources. What problems does this pose for countries that depend on imports to meet their energy needs?
3) If Mexico were to replace Saudi Arabia as a major oil-producer, what changes in the world energy situation might occur? What would remain the same?

3-6. Oil embargo

The event that greatly increased worldwide consciousness of the global energy situation was the decision of OPEC members to raise prices and to reduce production. In October of 1973, war between Arabs and Israelis broke out in the Middle East. Arab oil producers decided to cut back on their oil production and to stop supplying nations friendly to Israel. Earlier that year OPEC members had nearly doubled their oil prices, and by January of 1974, prices were quadruple their 1972 level. This had an enormous impact on countries all over the world, particularly since oil prices up to that point had been relatively stable for years. Because oil, on which modern commerce, agriculture and industry is based, became more expensive and less available, production dropped, causing a brief recession. This meant that businesses lost money and some had to cut back their production or lay off employees. There were also a number of effects on people's daily lives, such as shortages of gasoline which caused long lines at service stations.

Questions for discussion:
What do you remember about the energy shortages of 1973-4? What were the problems? How were they handled?

3-7. Chapter 3: summary

The "oil crisis" may have made people more conscious of energy, but it might also have encouraged them to regard the issue as a temporary topic, which would disappear or diminish with time. In the meantime, the discovery and production of oil in Alaska, the North Sea and Mexico has postponed severe shortages. The 1973-4 "oil crisis," however, was a symptom of a long-term problem which must grow more serious with each passing year: we are using up an ultimately limited supply of oil at ever-increasing rates. We must prepare now to face the problem of diminishing fossil fuel supplies, or else the future will have some hard shocks in store for us. Yet solving the energy dilemma is not a simple matter, because it is not a simple problem. Because energy plays a role in nearly every aspect of our life and society, energy problems, policies or decisions will have widespread effects. In the next chapter, we will examine the complex nature of the energy issue and discuss some of its effects in different areas.

Summary questions:
1) What is the nature of the energy problem? How did it come about?

2) How recent is this problem? How recent is popular knowledge of it?
3) Why might it more appropriately be called the fossil fuel crisis? or the nonrenewable fuel crisis?
4) Why and how has energy demand increased over the years? Where are major fossil fuel reserves located? How does energy demand compare with energy supplies? (in size, type, growth)
5) What were the major effects of the Arab oil embargo?

Chapter 3. References and suggestions for further reading

3-1. Renewable resources

Energy Research and Development Administration. "Energy History of the United States, 1776-1976." Excellent wall chart with energy time-line and the graph used in figure 17.

Denis Hayes. Rays of Hope: The Transition to a Post-Petroleum World. Discusses dwindling petroleum resources and use of renewable resources.

3-2. Energy demand

"The World Energy Crisis." Current History. March 1978 issue. Background of energy issue.

Great Decisions '78. Background and current status of energy situation.

H. Stephen Stoker, Spencer L. Seager and Robert L. Capener. Energy from Source to Use. Reviews background of the energy crisis, discusses energy supplies.

3-3. Exponential growth

Albert A. Bartlett. "Forgotten Fundamentals of the Energy Crisis." Excellent article on the implications of exponential growth in energy demand; basis of this section and source of graph in figure 18.

Lester R. Brown. Resource Trends and Population Policy: A Time for Reassessment. Discussion of exponential population growth and limited resources.

John McHale. World Facts and Trends. Good discussion of the concept of exponential growth, as illustrated by the "J-curve," and of global resources.

3-4. Fossil fuel demand

Federal Energy Administration. The Energy Challenge. Activity master with basic data and student exercises, including

the exercise adapted in this section.

Lon C. Ruedisili and Morris W. Firebaugh, ed. Perspectives on Energy--Issues, Ideas and Environmental Dilemmas. Readings on fuel supplies and demand include "Survey of World Energy Resources" by M. King Hubbert.

Washington State Office of Public Instruction. Energy, Food, and You. Lessons and data on current and historical use of fossil fuels, including graph in figure 19.

Workshop on Alternative Energy Strategies. Energy: Global Prospects 1985-2000. Authoritative projections of world energy demand and supplies; excellent graphs.

3-5. Fuel supplies

Exxon Corporation. "World Energy Outlook." A comprehensive survey of world fuel supplies and trends.

National Science Teachers Association. "Energy in the Global Marketplace" and "An Energy History of the United States." These curricula are sources of lesson outlines and graphs on the current situation and its background, such as the graph in figure 21.

The Organisation of Economic Co-operation and Development. The OECD Observer. The March 1977 issue contains a very good display chart of world oil flow in 1960 and 1975.

U.S. Department of State. The United States and World Energy. Basic background on energy situation and analysis of current world supplies, including data in figure 20.

World Bank. "Petroleum and Gas Outlook in Non-OPEC Developing Countries: 1976-1985." Paper on fossil fuel supplies.

Joseph A. Yager, Eleanor B. Steinberg et al. Energy and U.S. Foreign Policy. Overview of world oil and nuclear supplies.

3-6. Oil embargo

Jo Anne Buggey and June Tyler. The Energy Crisis: What Are Our Choices? Readings on 1973-4 oil embargo and the consequences.

James Martin. "The United States and the Energy Crisis: A Study in Economic Decision-Making." Discussion of the 1973-4 energy crisis.

Daniel Yergin. "The Real Meaning of the Energy Crunch." How the oil embargo came about and its effects on international relations.

CHAPTER 4. ELEMENTS OF THE ENERGY ISSUE

The current energy situation has developed over the years as the result of a multitude of factors and individual decisions, including the low price of oil, the increased use of fossil fuels in internal combustion engines, and the growth in popularity of more energy-intensive processed foods. Energy use has a widespread effect on our lives, from the way we travel, to the quality of the air we breathe, to the price of fertilizer in Indonesia. The effect of more expensive energy has been felt differently in different parts of the world and in different sectors of society. This means that solutions to the dilemmas posed by the energy problem will not be the same for every nation or group.

Because complexity is characteristic of any global issue, we should try to examine all aspects of an issue before deciding what should be done. The four major aspects of the energy issue are:

1) environmental
2) economic
3) political
4) social

This chapter of Energy in an Interdependent World will introduce and briefly sketch these aspects and how they interact, in order to give an idea of the range of areas that are involved and that must be considered in a study of world energy.

Environmental

The complex nature of the energy issue may be more easily understood if we begin by studying its ecological effects, because ecology is specifically the study of complex systems. Ecologists study the interdependent relationships between the various elements of biological systems. Man and the energy he uses are inseparable parts of the biosphere--the total biological environment of the earth--which is affected by energy use and, in turn, imposes limitations upon it.

4-1. Firewood crisis

Environmental damage brought about by energy use is not a new

phenomenon, nor is it limited to the industrialized countries. In fact, there is a less well-known energy crisis occuring in countries that use very little fossil fuel energy: the firewood crisis.

In many areas of the world, the primary source of fuel for cooking and heating is the firewood gathered daily. As you can infer from the results of your exercise in chapter 3, section 3-1, this would be a secure supply of fuel only so long as the rate of gathering is less than or equal to the rate of replacement, as was the case in these countries in the past. In recent years, improved sanitation and health care has drastically reduced the death rate throughout the world, while birth rates have been slower to decline. This has resulted in large increases in population and in the rates of population growth. The soaring population growth has put increasing pressure on firewood supplies. In many regions, wooded areas are growing smaller, and the land is becoming denuded of covering vegetation, as families seek the necessary fuel for heat and cooking.

The stripped land is much more vulnerable to erosion, and the loss of topsoil means permanent damage to the fertility of the land, as well as greater amounts of silt and mud in the area's rivers, dammed-up lakes and waterways. This is a serious problem in the Himalayas and northern India.

A similar problem occurs in areas where dried cow dung is used as a fuel. As the number of people in an area increases, more dung is used for fuel, and less is used to fertilize the fields. The increased population also means a need for increased food production from those same fields which are receiving less fertilization.

Deforestation is a crisis in renewable fuels and is particularly critical in Third World areas, such as Haiti, though it has been a problem in other places and times.

Questions for discussion:

1) Why do you suppose this energy crisis has received less attention than the oil crisis?
2) What might be done to ease the firewood problem? How could the use of fuel for heating and cooking be made more efficient? Why would better stoves need to be made from cheap and locally available materials? What alternative energy sources could be used?

Activity:

Read "The Myth of the Sacred Cow" by Marvin Harris and "The Sacred Rac" by Patricia Hughes. (See Bibliography for full citation.) How do the examples of the cow and rac show the interconnections between energy and the environment, economy and culture of an area?

4-2. Obtaining energy

Obtaining fuel, i.e. locating, extracting and transporting it, has ecological effects before the fuel is even used or burned. We have examined the ecological problem posed by excessive harvesting of firewood. Other renewable sources of energy may pose environmental problems as well. Solar collectors and windmills may obstruct the scenery with "visual pollution," use land valuable for farming or housing or other uses, and in the case of windmills, cause some noise pollution. Geothermal energy sometimes involves the use and tolerance of unpleasant smelling gases and brines, which could pollute the water table with salts, and the combustion of garbage for energy may also cause foul odors. We will explore the advantages and problems of renewable energy sources in more detail in chapter 5.

Let's now focus on some of the effects of obtaining nonrenewable, fossil fuels. Coal can be mined either underground or on the surface, in strip mines. Underground mines are more expensive to operate and more dangerous to work in, but pose fewer environmental problems, although they can pollute the underground water supply, because most of the waste rock is left underground after coal has been extracted. Strip mines require fewer miners to operate, but can desolate a countryside unless properly managed. In strip mining, the earth is literally torn up, leaving large loose piles of rock and dirt open to rapid erosion unless they are replanted. Large amounts of water are also required to separate the coal from the rock waste, and the water used becomes polluted and acidic. This is a particular problem in the western U.S., where there is often little water for agriculture or household use, let alone large-scale strip mining.

Oil poses different risks particularly in refining and transporting. Although drilling itself poses risks of explosions or fire, widespread damage to the environment is relatively small. Refining oil, however, releases pollutants into the air, and transporting or storing oil risks spills and explosions on land and in the water. The oil spills in oceans and rivers are especially damaging, because they affect wildlife in the water and on the beaches, and are harmful to sea birds. Large amounts of oil spilled or routinely flushed out of empty tankers can "choke" the ability of coastal oceans to break down the oil, chemicals, sewage and other wastes we dump into the oceans or rivers. This is particularly critical in light of the increasing amounts of food harvested from the world's oceans.

The primary danger of the third major fossil fuel, natural gas, is in its bulk and explosiveness. Gas can be transmitted relatively short distances by pipeline, but long-distance shipping requires that the gas be liquified. Liquified natural gas (LNG) requires energy to keep it cold and under pressure, which means

higher processing losses, and it's potentially explosive as well. Natural gas, however, is the most efficient and cleanest fossil fuel in terms of heat and air pollution from combustion.

Questions for discussion:

1) What are the potential dangers to the environment-land, air and earth-in obtaining coal, oil, and natural gas?
2) How could such things as proper management of strip mines and safety regulations for miners, tankers, and storage facilities reduce environmental risks? What else could be done?

Activity:

View a film or filmstrip on oil or gas production or on coal mining. (See chapter references for suggested titles.) What are the environmental problems? How are they being handled? Could more be done?

4-3. Energy conversion

The primary source of ecological problems is the conversion of energy to usable forms by the combustion or fission of fuels. Based on your knowledge of thermodynamics, what will be produced in every energy conversion? It may not seem that low-level heat would pose a problem, but we are only beginning to learn about its effects.

Nuclear power plants must face the problem of thermal pollution, because they can produce very large amounts of energy in a single location, thus producing large amounts of waste heat. In addition, it is absolutely necessary for the core of the reactor (where the reaction takes place) to be kept cool, or else the reaction will get out of control. You may have seen pictures of cooling towers at nuclear plants, which cool the water that contains heat from the reactor. It is still uncertain how these affect atmospheric and weather conditions, but the cooling towers are preferable if the alternative is releasing heated water into streams and rivers or oceans. It is known that even a relatively small rise in water temperature can harm the ecological balance of marine systems, and cause streams to "die," or become unable to support life. Thermal pollution is a problem common to all generating plants, including those that burn fossil fuels.

Another problem that results from the combustion of fuels, particularly fossil fuels, is air pollution. The presence of black smoke and soot or urban smog made this ecological effect visible some time ago. Emission controls on automobiles have been in force for a while, because automobiles are responsible for a large part of urban air pollution. Coal-burning factories have been required to use very tall smokestacks, filter systems, or other means to prevent pollutants from escaping into the air.

Unfortunately, we are beginning to discover that solving one environmental problem often creates another. The tall smokestacks on industrial plants prevent many pollutants from entering the surrounding area, but force the remainder high up into the wide-ranging winds, which carry the pollutants to more remote areas. For example, polluted winds from industrial areas in Pennsylvania and in the Ruhr valley of West Germany rain down diluted sulfuric acid on the forests and wildnerness areas of the Adirondacks and Scandanavia, respectively. Efforts in the U.S. to reduce air pollution by requiring the use of less polluting, low sulfur coal have meant increased use of strip mines in the western states, where this coal exists.

Scientists are beginning to express concern about the build-up of carbon dioxide in the world's atmosphere. A product of combustion, CO_2 is a particular problem with the large-scale burning of coal. The CO_2 layer, as it gradually increases, may trap the earth's heat and cause a rise in temperatures worldwide. The consequences are unpredictable and potentially serious, because the world's weather and climates are based on the present balance. If climate zones in the Northern Hemisphere suitable for food production, for example, were to shift some 200 miles north, the American Mid-west, most of Europe, and large areas of Asia would suffer a change in climate and thus in possible crops, although other food production may become possible in currently unproductive areas. Even energy conversion methods which do not involve combustion or fission, such as solar, wind or geothermal power, have an impact on the environment, as we noted earlier.

Questions for discussion:

1) What are the dangers of air pollution to humans, plants, and animals?
2) How can the dangers to the environment from energy conversion be reduced by using less energy or cleaner fuel, devising better pollution-control techniques, or finding less polluting energy alternatives?

Activity:

Visit a generating station that uses fossil fuels, or view a film or filmstrip about one. (See chapter references for suggested titles.) What are the environmental problems? What has been done to alleviate them? What more could be done? Where are the nearest generating stations located?

4-4. Waste products

Finally, there are ecological effects from the products of energy use. This is most dramatic in the case of nuclear energy plants, which produce radioactive wastes. Although some of this waste can be processed and recycled back into the

reactor, there still remain wastes to be transported and stored that will be highly toxic for a relatively long time. With the development of "breeder" reactors, which can use reprocessed fuel, there is also the problem of sabotage or theft of the very radioactive fuel at or on its way to reprocessing plants. The fuel is suitable for constructing a nuclear bomb, and thus poses the risk of terrorists or countries obtaining nuclear weapons. The controversy surrounding the construction of new nuclear power plants is at least partly due to concern about the safe transport, disposal and storage of nuclear wastes.

Waste problems also result from the energy-intensive methods which have developed over the past century. When energy was cheap, for example, aluminum was less expensive to refine from ore than to obtain from recycled aluminum products. Besides wasting energy, however, this kind of method creates large amounts of waste (in this case aluminum), which must be disposed of. As cities and towns grow, they find it harder and harder to dispose of waste by dumping it on land or at sea without suffering environmental damage. Recycling waste (whether metal, paper, glass or organic waste for energy production or fertilizer) can substantially reduce both energy requirements and the volumes of waste to be disposed.

Questions for discussion:

How does your community dispose of solid wastes (i.e. garbage picked up) and sewage wastes? How do these methods affect the environment? Does your community have a recycling or waste recovery program? Is garbage burned to provide energy?

Activity:

Visit a waste treatment plant or a recycling center, or talk to your local sanitation department. How does garbage collection and disposal require energy? How could it be made more efficient?

4-5. Environment: summary

Energy and the environment are related in all stages of energy use, from mining and shipping to burning fuels and dumping waste. The environmental effects of energy are also interrelated, as the case of the tall smokestacks indicates, and thus the effects of policies for energy production and use must be fully explored or studied. A study of the ecological aspect of the energy issue illustrates its complex nature. There are many sources of energy and many uses, each with different effects in one area or another. If strain is put on the ecosystem in one area, the effects may appear in another and unexpected area, as when fish die in acidic Adirondack streams because of tall chimneys in Pennsylvania. Wide-ranging and unexpected effects are characteristic of complex

systems. As we turn to the other major areas of the energy issue, keep in mind what you have learned: that complex systems involve many aspects of life, that these aspects are closely interrelated and thus are all important to the functioning of the system, and that nothing can be changed without some effect, foreseen or unforeseen, on the rest of the system. For example, an environmental effect like air pollution can have economic repercussions, when workers become ill and unable to work.

Summary activity:

For one of the ways you use energy daily (eg. lightbulbs), diagram the full process of obtaining that energy, and for each step, indicate possible sources of pollution and means of prevention.

Economic

Economics is concerned with the production, distribution and consumption of goods and services. Energy is a vital commodity, because it is necessary in the production, distribution and consumption of all goods and services. Energy itself is not scarce, but its most desirable and easiest-to-use forms, fossil fuels, are limited in supply, while worldwide demand for them has risen sharply and still continues to rise. The balancing of supply and demand is the central problem of economics. When supplies are not sufficient to meet demand, consumers face difficulties in obtaining what they want. These difficulties may include higher prices, shortages or even rationing, if the commodity involved is a necessary one.

In this section, we will look first at the interconnections between energy use and the economy, then at the nature of OPEC's control over fossil fuel supplies, and finally at the effects of and adjustments to higher oil prices.

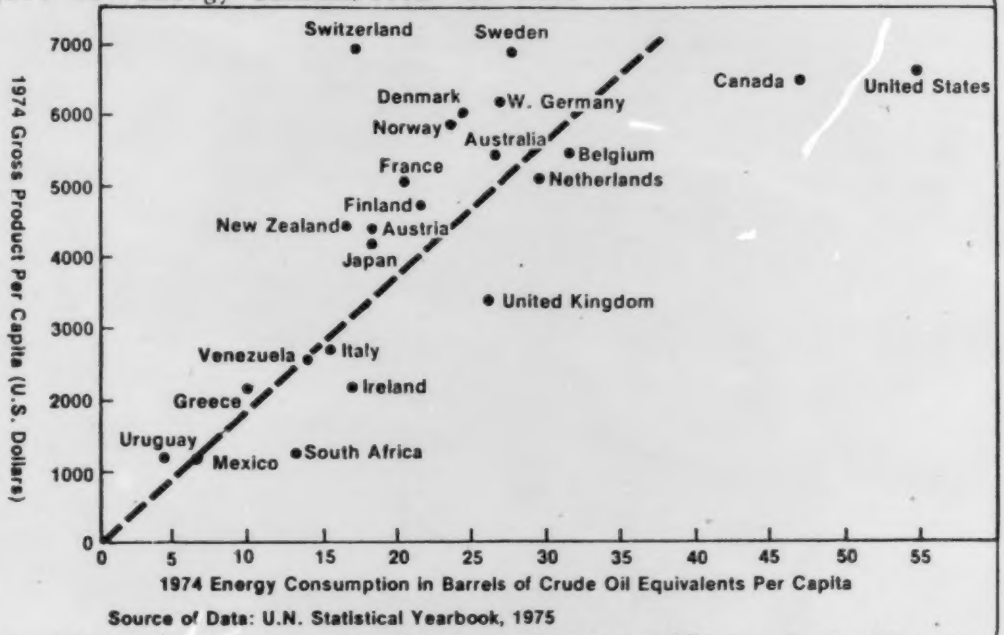
4-6. Energy and the economy

We discussed briefly, in section 3-2, the historical relationship between economic growth and growth in energy demand. As the economy of any nation has grown, the demand for energy energy has grown, because

a) the production of more goods and services requires more energy, and
b) as individual incomes have grown, people have used more energy.

Look at the graph of GNP per capita versus energy consumption per capita, figure 22, on the next page. The GNP, or Gross National Product, a statistical indicator of the relative wealth of a country, is the sum of all goods and services produced in a country in one year. An increase in this figure

Figure 22: Energy Consumption Per Unit GNP



Source of Data: U.N. Statistical Yearbook, 1975

from: The National Energy Plan, Executive Office of the President, Energy Policy and Planning Council, 1977, p. 3.

from one year to the next indicates economic growth. As a very rough indicator of the general standard of living, the GNP is divided by the number of people in the country, to obtain a figure for GNP per capita. The GNP per capita does not represent the average income for the country's citizens, because it gives no indication of how the country's wealth is distributed, but it can give a rough idea of the standard of living of that country, relative to other countries.

Questions for Discussion:

1) What generalizations can you make from figure 22 about the relationship between a country's economic status (as expressed by GNP per capita) and the amount of energy consumed by that country? What are the likely implications of this relationship for the future energy requirements of a nation that seeks economic growth? What will be the likely effect on world energy demand as developing nations expand their economies?

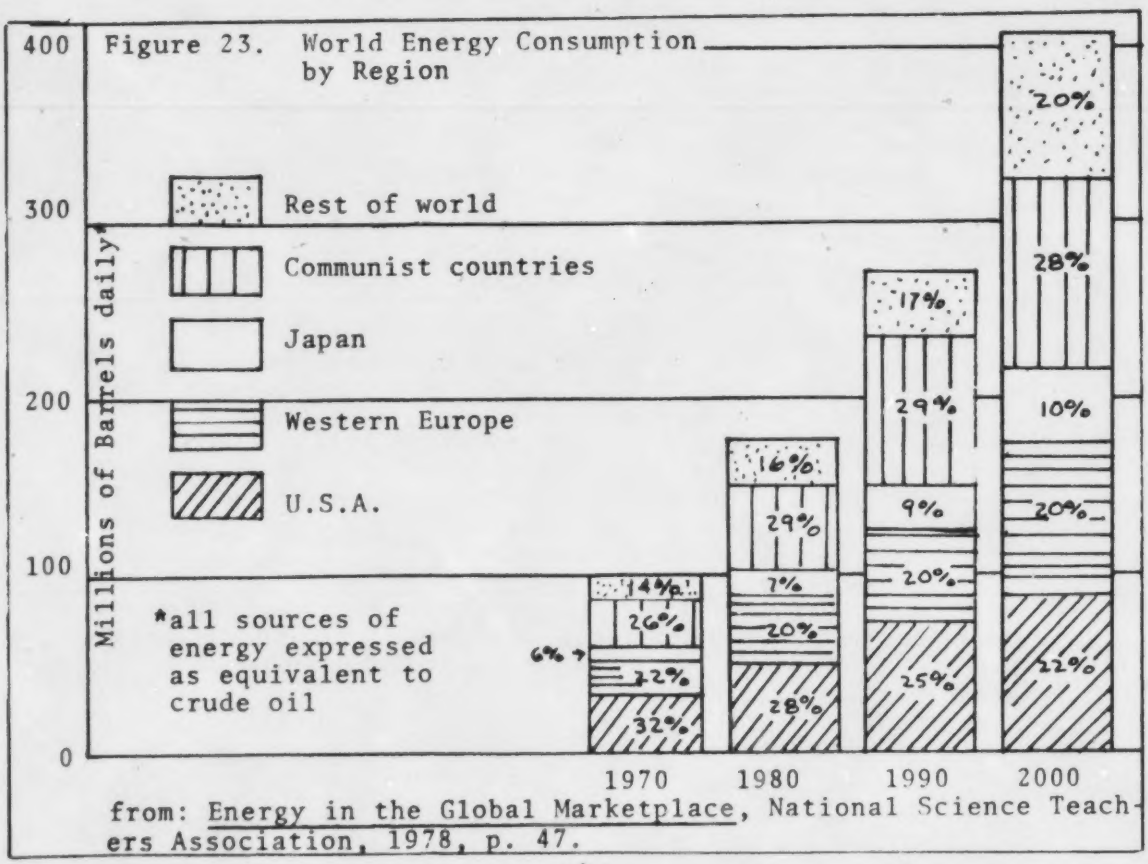
2) On the other side of the picture, how might reductions in energy consumption, voluntary or imposed, affect economic growth? Taking a closer look at the graph, how do consumption rates among the relatively wealthy countries compare?

There are a number of factors that could account for the varying rates of consumption among countries with similar standards of living. Better conservation methods (often adopted because energy prices have been high for a longer time in some areas) and milder climates affect energy consumption. Also, the proportion of energy-intensive industries, such as mining and metal refining, to more labor-intensive industries, such as textiles and electronics assembly, differs among countries.

It may be possible to slow the growth in energy consumption without causing severe economic strain, by implementing conservation measures, using alternatives that require less energy and avoiding wasteful practices. In other words, we may find that economic growth need not depend on equal growth in the use of energy. Unless conscious efforts are made toward this goal, however, energy demand may not stop growing until the economy stops growing. A slowdown in the growth of the economy would mean serious adjustments and some reductions in the standard of living.

4-7. The oil cartel

Economics involves the balancing of supply and demand. Demand for energy is growing (see figures 2 and 23 on world energy consumption by source and by region), and oil demand is increasing



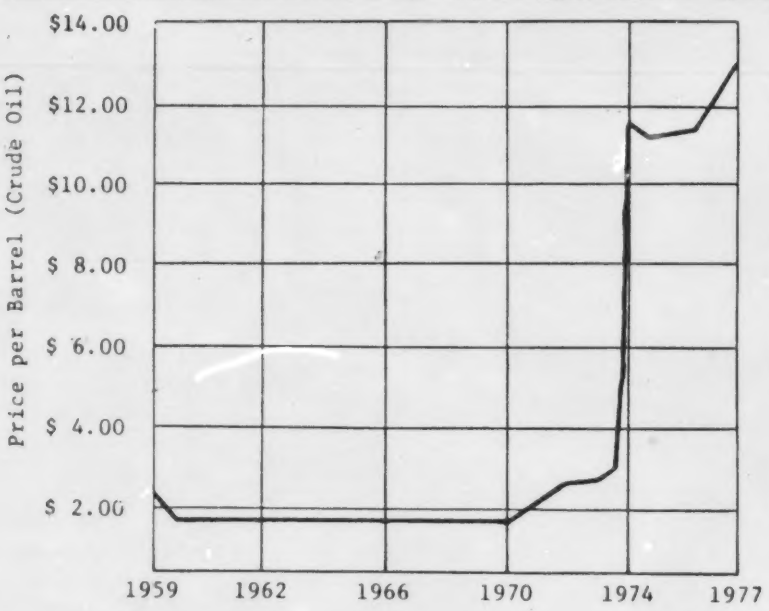
from: Energy in the Global Marketplace, National Science Teachers Association, 1978, p. 47.

at an even faster rate. We noted previously, in Section 3-5 that oil supplies are unevenly distributed and ultimately limited. The situation, of large and growing demand for a necessary commodity, supplies of which are limited and controlled by relatively few countries, gives the oil-producing countries the potential for substantial economic power. The Organization of Petroleum Exporting Countries or OPEC was formed in 1960 to increase the members' economic power by coordinating the policies of the major oil suppliers. (See figure 10, page 12, for a list of member nations.)

An international group of firms (in OPEC's case these were national oil companies) formed to control production and sale of their products is known as a cartel. A cartel is much the same as a monopoly, except that it may not include all the producers of that product. The success of the cartel depends on the willingness of the members to unify their policies, so as not to undercut each other by reducing prices or increasing production and getting all the business. OPEC has been quite successful in this regard. [See figure 24 on this page for graph of oil prices.] This success is partly due to the nature of oil production. Unlike in agriculture, where the amounts produced depend on weather conditions and other factors outside government control, the amount of oil pumped out of existing oil wells can be regulated, either by the oil

Figure 24:

Arabian and Persian Gulf Crude Oil Prices



from: An Energy History of the United States, National Science Teachers Association, 1978, p. 109.

companies or by the government of a country. Oil is also a continuous, year-round "crop" in most places. It can usually be stored or simply left in the ground if prices are not high enough to satisfy the oil producers. The OPEC countries have been able in most cases to agree on production quotas for their member countries, which maintain a level of world oil supplies that keeps prices high.

Class activity and discussion questions:

As a class, take part in an economic simulation game, such as "Economic System." (See Bibliography for further reference.) If there is enough time, you may want to play the game a second time, switching roles.

1) What conclusions can be drawn about how the economic system works? Can you find any parallels between the simulation game and the oil situation?

2) How could you adapt the graph of international oil trade, p.34 to show, roughly, the flow of money in payments for oil? What areas are focal points?

3) Why does the oil cartel work? What might cause it to fail or split apart? Do you know of any other cartels?

4) The oil-exporting countries, understandably, want to get the maximum benefit from their oil resources. Consider the advantages and disadvantages in these economic policy options: reducing oil production to save oil for sale in the future; investing in and aiding less developed countries to encourage their economic growth; developing industries and other sources of income in their countries; investing in alternative energy sources.

5) How could the oil-consuming countries "fight back"? Why would boycotting (or refusing to buy) oil be difficult for most countries for long periods?

6) When do further increases in prices stop being effective for increasing the revenues of the oil exporters? How do the large investments of OPEC money in the industrialized countries make oil importers and exporters interdependent upon each other's economic stability?

4-8. Price increases and the economy

The effects of increases in oil prices moved outward in a "ripple" pattern from oil and its direct products to petroleum derivatives to other areas of the economy, such as transportation, which in turn affected such things as food prices, postage rates and airfares. This ripple effect is characteristic of complex systems whose parts are interdependent. The sharpness of the rise in oil prices, coupled with the importance of oil in nearly every aspect of modern life, made the ripple effect a near tidal wave. The worldwide economy as a whole suffered a slump, and parts of it have yet to recover.

The higher prices for fuels reduced the profits of many businesses, reduced the spending money of individual consumers and

took a larger share of government funds. Moreover, much of the extra money paid for oil went to the oil-producing nations, rather than recirculating within the national economies of oil-importing nations. This cut back the economic growth of oil-importers among both developing and industrialized nations. In addition to the direct effects of higher prices for oil imports, the economies of the developing countries experienced two indirect adverse effects:

1) the prices of imported manufactured goods, particularly petrochemical products, rose to cover increased energy costs, and
2) the slump in economic growth meant a corresponding reduction in buying power among the industrialized nations. These nations bought fewer export products from developing nations, which reduced the developing nations' export earnings at a time when their energy expenses were rising.

Economic growth in most countries has revived since 1973-4, but often at a slower rate. Inflation has also increased, however, and higher oil prices have been an important factor in this trend. Renewed economic growth and aid to developing countries, especially from the OPEC nations, has helped them adjust to the extra burden of high energy costs.

4-9. Energy and agriculture

A rise in oil prices also means a rise in the prices of things made from petroleum. Natural gas and coal can also be used as feedstocks, or sources, of petrochemicals, but oil has been most widely used because of its availability and transportability. Petrochemical products have become, in many areas, an integral part of the economy, both in the industrialized and the developing nations.

Pesticides and fertilizers are among the petroleum-based products which are most important to developing nations. Fertilizer is particularly critical in fields planted with newly developed strains of wheat and rice. These "wonder-breeds" have very high yields and were developed to provide more food per acre in areas where many are hungry, but they require relatively large amounts of irrigation and fertilizer. Thus, price increases in petroleum, which increased the price of fertilizers, hit hard those developing countries which could little afford it.

Petroleum-derived fertilizers are one part of the more energy-intensive methods of modern agriculture. Combined with the increased use of tractors and other farm machinery that use fossil fuels, they have greatly increased farm productivity over the past years. If oil prices continue to rise, the cost of growing food will continue to rise, particularly where energy-intensive agriculture is practiced.

Questions for discussion:

1) In your opinion, what will be the general trend of oil prices in the future? How will this affect the costs of mechanized farming and petroleum-based fertilizer?

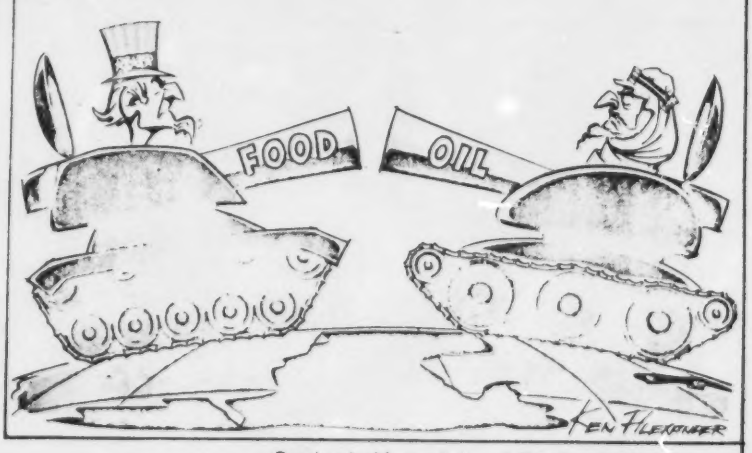
2) How will oil-importing countries be affected by this trend? How about countries that must import food? The U.S. is the world's largest food exporter. Would you characterize the agricultural methods there as energy-intensive? Who would be affected by higher prices for U.S. food?

3) What are the advantages of farming methods, such as fertilization and irrigation, that use more fossil fuel energy? How does the use of machines affect the number of workers needed on a farm?

4) How can countries ease the burden of agricultural energy costs? Consider ways to reduce energy needs in agriculture, to increase earnings from exports, or to obtain outside aid.

5) Look at the cartoon in figure 25. How can food or oil be used as an economic weapon? How would higher prices for both commodities affect the U.S. and the Arab oil exporters? What effects would embargos or boycotts have? Consider these factors: the ability to find other suppliers or to substitute alternatives, the renewability of the commodity and the relationship between modern agriculture and energy consumption. Cartoons make their point by simplifying an often complex situation. How has this cartoon done so? What are the possible risks of such a simplification? How would the rest of the world be affected by an "economic war" between the U.S. and Arab oil exporters? How might you redraw the cartoon to show the perspective of a country that imports both food and oil? What advantages does international economic cooperation have?

Figure 25: Cartoon



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from: The Energy Crisis: What Are Our Choices?, JoAnne Buggey, June Tyler, 1976, p. 91.

4-10. Adjusting to higher prices

We have discussed some of the more immediate effects of the oil price increases, to gain a sense of the complexity and interdependence of the world economy. Let's now look at possible future effects, as the economy adjusts to higher prices. Economically speaking (we will discuss the political and social aspects later in this chapter), higher prices for oil may be regarded as a tool for bringing about needed changes in the world energy market.

In the short run, the problem is matching oil supply and demand, and increased oil prices can mean:

1) the discovery and recovery of more oil. As prices rise, it becomes profitable to use more expensive techniques to "squeeze" oil out of underground deposits. Higher prices for the oil they do find makes it possible for oil companies to spend more money on exploring for oil. More discovery and recovery would increase available oil supplies,

2) conservation of or substitution for oil. As it becomes more expensive to waste fuel, and as the money saved by reducing fuel use rises, individuals and businesses will increase conservation efforts. Money spent on insulation and other fuel-saving methods will be paid back sooner in fuel savings.

In the longer run, there will need to be a shift from primary dependence on fossil fuels, to the greater use of more plentiful and renewable sources of energy. Higher oil prices can help speed that transition by:

1) making alternative sources of energy (most of which are, at least initially, more expensive to use than fossil fuels) more economically competitive.

2) encouraging development of more energy-efficient technologies and encouraging research into energy alternatives. As oil prices continue to stay high, research into the various alternatives will be a good investment.

The reason for the great economic impact of oil price increases is the role that oil has come to play in the development of modern economies, a role that will not be easy to change. Oil is a necessary intermediary in countless products and processes. For example, when we want to get from here to a distant there, we most often use gasoline, diesel or jet fuel. To change an entire transportation system, or even to replace worn-out vehicles with those that use other fuels or simply get better gas mileage takes time. So does changing our agricultural and industrial methods and machines. Because the price hikes are immediate and the adaptations to it longer term, the adjustment period will be accompanied by some confusion, inconvenience and necessary sacrifice.

Higher energy prices and their effects are not solely due to oil price hikes. Nuclear energy has become more costly as construction costs for plants rise, and as more stringent safeguards are imposed. Coal, too, has become more expensive as miners gain higher wages, as mine owners must meet safety measures, and as coal burning plants meet stiffer requirements on air pollution. Alternate technologies, like solar, wind, or biomass energy, are often still expensive because of the materials required and the lack of large-scale manufacture or use to offset the cost of individual units.

The world economy will have to adjust to higher energy prices, but the primary challenge we face is to make the transition from heavy consumption of expensive but available fossil fuels to more moderate consumption of both alternative energy sources and very expensive fossil fuels.

Activity and discussion:

Recalling our discussion of energy in our daily lives, section 1-2, how will rising energy prices affect your choices and use of energy? At what price per gallon of gasoline, for example, will (or did) you begin to change your driving habits? What alternatives are there? At what price would you be forced to stop using gasoline? Find out from your family or your school or college how rising energy prices have altered the budget in the past few years, and what changes this has caused or encouraged.

4-11. Developing countries

Examine the graph, figure 23 of energy consumption by region. You will note that the developing countries use much less commercial energy than the industrialized countries. Commercial energy is energy bought, sold and produced on a relatively large scale, such as oil or hydropower. It does not include most traditional sources, such as firewood or rice straw burned in a farmer's cook stove. Yet in most developing countries, non-commercial, traditional energy sources account for at least one-half to three-quarters of the energy consumed. Less commercial energy is used than in the developed countries, because of the smaller amount of industry and mechanized agriculture. Most developing nations, however, want to expand their industries, improve agricultural yield and offer a higher standard of living to their citizens. All these things require energy. Yet the less developed countries often face problems of dwindling traditional energy sources, more expensive fossil fuels and growing populations. Population growth alone, without including economic growth, will mean greater demands for energy. As discussed in section 4-1, this has already created a firewood crisis in some areas, as traditional, renewable fuels are used up faster than they can be replaced. Many developing nations, therefore, are increasing their consumption of commercial energy sources, particularly of the

fossil fuels required in modern industry and agriculture.

The developing countries are at a crossroads of energy paths. The path most traveled in the past has been the one of intensive use of fossil fuels and the development of economies and infrastructures based on their use. As of yet, this is still the path of least resistance; the technologies, machines, processes and markets for fossil fuel-based industrialization and agricultural improvement are already available and proven. Even with the current oil prices, oil is still cheaper now than many of the alternatives because the distribution networks exist already and because it is a versatile, transportable, high quality fuel. However, because of today's high oil prices, the fossil fuel path ain't what it used to be, and its future looks bleak, as prices continue to rise and competition, especially with the major industrialized oil importers, begins to increase.

Because most developing nations have not yet completely converted from traditional to fossil fuels, and have not yet invested irreversably in a fossil fuel infrastructure of tanker ports, refineries and pipelines, they are in a better position than their industrialized neighbors to avoid the fossil fuel path and base their development on more renewable energy sources. In fact, renewable energy is more suited to the smaller-scale, dispersed energy needs of nations with populations in rural, agricultural villages than the larger-scale, centralized fossil fuel systems which require expensive distribution networks. The choice of developing renewable energy sources is not without disadvantages, particularly at the outset. Technologies based on renewable energy sources most often do not exist or are not widely available, and developing nations frequently lack the money and institutions to support extensive research and development of such technologies. Because the machines, methods, etc. using renewable fuels are not so widely available, the initial expenses of research, design, construction, and implementation are high, and these high costs are faced by those countries who are least wealthy and who were caught in the double bind of high-priced oil imports and reduced export earnings. With aid and assistance from the developed countries or from OPEC countries, however, the developing countries might overcome the initial obstacle of higher costs and move from traditional to renewable energy sources without the intermediary step of fossil fuels.

Questions for discussion:

1) Do you think it may be possible for developing nations to avoid the historical pattern of oil-dependent development, and develop with alternate energy sources? What problems might they encounter, for example, in the lack of research facilities? What help might they need?

2) How could industrialized and less-developed nations cooperate on energy issues? What would each group gain or lose?
3) Optional question for further study. How might developing nations use the manpower potential of their populations to substitute for fossil fuel needs; for example, in construction projects? In what areas might this be impractical, for example, telecommunications or steel manufacture? What would the advantages be of a world economy distributed so as to get maximum benefit from each countries' natural resources, e.g., electricity-intensive industries in countries with hydropower, petrochemical industries in countries with oil, handcraft industries (electronics, textiles) in countries with large labor forces? Why might countries prefer instead to diversify their economies or to possess and exercise control over all important industries?

4-12. Economics: summary questions

1) Describe some of the immediate effects of the sharp oil price increases of 1973-4 on the world economy. What are some of the longer-term effects? How were the industrialized nations affected? the developing nations? the oil-exporting nations?
2) How do high oil prices affect food production costs? economic growth? developing country exports? What long-term effects might high prices have in the future?
3) How would industrialized, OPEC and developing nations benefit economically from a relatively calm transition from oil-based economies to economies based on renewable or more available energy sources? How might developing nations benefit from a direct transition from traditional to renewable energy sources?
4) How do the economic effects of energy indicate global interdependence? How are they related to environmental effects?

Political

Economics and politics have always been closely intertwined, on an international level as well as within nations. One can infer a good bit about the political effects of the fossil fuel situation by examining the worldwide economic effects. The economics of fossil fuels, in turn, combine with the ecologically destructive potential of nuclear fuels to create a tense, global political issue.

The basic motivating force behind international politics is the desire of each nation for independence, security and well-being; a desire also basic to every human individual. In the world of today, as throughout most of human history, national independence, security and material well-being have depended on

diplomatic, military and economic strength. Diplomatic strength is the ability to convince potential aggressors that they will gain less by agression than by neutrality, if not friendship, and depends in part on a nation's military and economic strength. Because energy resources are necessary to the strength of a nation's armed forces and its economy, they are of great political importance. Let's examine the political elements of the global oil and nuclear situations, in particular, to give us insight into the politics of energy in an interdependent world.

4-13. Oil politics

Oil has as important a role in modern military forces as it does in the modern economy at large. Tanks, jeeps, jet planes and destroyers all use petroleum fuels. To ensure a secure supply of oil in the event of war, nations must either stockpile large quantities or rely on uninterrupted supplies from reserves they control or can obtain from other countries. This gives extra weight to the already important role of secure oil supplies for the normal functioning of the economy.

Questions for discussion:

1) Look at the graph of the flow of international oil trade, figure 21. What do you hypothesize are some of the political implications of this situation? How would you characterize briefly the stability of the political situation in the Middle East? Between Arab nations and Israel? Between Soviet-allied nations and U.S. allies? Within the nations of the area? Why is political stability in this area important to the rest of the world? Why is Iran particularly important to the U.S. and U.S.S.R.? What is the current situation there? What were the effects on international oil trade of the Shah's recent downfall?

2) Where else is oil produced? How stable is the political situation in these countries? (Your teacher may choose to assign students as individuals or groups to study the political situation in key areas or nations and its effect on the global energy situation.) The major tanker routes are also of strategic importance. What countries do they pass? Where are the key passages and intersections? What is the situation in these countries, particularly the Horn of Africa? Can oil tankers pass through the Panama Canal?

3) Who are the large oil consumers? What political problems might arise among them in competition for oil? Given the military commitments of the U.S. to the NATO forces of western Europe, why might European countries be especially concerned about U.S. dependence on oil imports? The risks of political wrangling over oil supplies could be reduced if oil-importers diversified energy sources and suppliers, and instituted an oil-sharing authority. How much has been done in these areas?

4) Since a large part of the world has not been as carefully explored for oil and gas resources as the Middle East,

Europe and the U.S., it seems likely that there may be other nations with significant amounts of oil to export in the future. Mexico's oil reserves, for example, have proven much larger than originally estimated. There is also potential for major reserves in the USSR's Siberian regions and off the coast of China. How might this shift the economic and political balance of the energy situation? What might be the effects if the new exporters joined OPEC? if they did not join, but competed with OPEC? How might political alliances, domestic economic situation and the amount of oil needed for domestic use help determine whether or not an oil-exporter joined OPEC?

4-14. Nuclear politics

Nuclear energy poses a different set of economic, political and military issues. Scarcity and distribution of fuel (uranium ore) is important in existing reactors, but less of a factor in the use of "breeder" reactors which can drastically reduce the need for new nuclear fuel. Scarcity of technology is a serious hindrance to the adoption of nuclear energy by developing countries, because the details of nuclear power plants are fairly closely controlled. The overriding source of concern, however, is the potential destructiveness of nuclear fuels, either as embodied in nuclear weapons or in accidents at the reactors or waste disposal sites.

The U.S. and several of the other major nuclear powers want to prevent or discourage other nations from obtaining the means to make their own nuclear weapons. They fear that the wide spread of nuclear weapons will increase the chances of their being used, which could trigger a worldwide nuclear war. It also has been shown that the technology used in "peaceful" nuclear reactors and the radioactive products generated can be converted to military use. Thus, the U.S. and others regard nuclear power plants as potential sources of nuclear weapons. There is also a danger that nuclear plants may be targets for terrorists, who want either to disrupt or destroy the plants and the electrical supply of the region, or to obtain enough radioactive material to make their own bombs.

The U.S. has exerted its influence in opposition to the sale of nuclear plants to countries which are not already nuclear powers. Since the U.S. is currently the site of much of the nuclear power technology, fuels and reprocessing facilities for nuclear wastes, it exerts a strong influence. Other nations, such as India, protest. They are often lacking in other energy resources, particularly fossil fuels, and wish to avoid dependence on energy imports, both for security reasons and to avoid further economic costs. The countries that own or acquire nuclear weapons also gain a certain amount of military and political power, by being able to exercise the threat of using their weapons. India sees the tremendous energy-producing potential of nuclear reactors as

the answer to the energy requirements of development and industrialization. The U.S., many feel, is denying developing countries energy independence and sufficiency because it wishes to maintain the power of the nuclear status quo. India surprised the existing nuclear powers in May 1974, by detonating a nuclear bomb, which utilized the fuel and technology derived from its "peaceful" nuclear generating plants. Nor is it only the developing countries which disagree with a nuclear moratorium (or halt on new activity). Other industrialized countries, particularly France, which depend upon imported oil, feel that the U.S., with its rich energy resources and sizeable nuclear energy system, cannot dictate energy or nuclear policy. France is currently constructing a new and very large breeder reactor, Superphénix.

Questions for discussion:

1) How does the desire for security underlie the U.S. position on the proliferation of nuclear facilities? How do the policies of countries like France and India also reflect desires for security, independence and well-being? What large world power borders on India? Who are the major nuclear powers?
2) Nuclear energy development in many countries has been held back because of uncertainties about safety, security and waste disposal; nor is it appropriate to every country, since it requires a relatively large, existing electrical power network, a high level of technology and large initial costs for construction. Before it can be used more widely on a global scale, the world's nations will have to work out its accompanying political problems or perhaps face more serious risks of destruction.

4-15. Politics: summary questions

1) Why is energy of political importance?
2) How is politics closely tied to the geography of resources and transportation routes? Where are energy resources, other than oil and uranium ore, located? Can they be transported to other countries?
3) Why does nuclear energy pose international political questions?
4) How might an international energy authority help alleviate some of these political disputes? Why might countries object to such an authority?
5) How are political and economic aspects of energy use interrelated?

Social

Because energy is so much a part of our lives and lifestyles, changes in energy use or policy have significant social effects. It is only in the more recent past, that we have begun to be interested in piecing together a picture of the broad social

effects of government policies, economic trends and business practices. Improved techniques and interest in ecology and sociology, that is, in the study of the interactions of biological or human individuals and groups, have increased our understanding of complex systems. Policies and practices are being examined with an eye to their potential costs and benefits to society, and governments, companies and individuals are being asked to accept responsibility for the social costs of their actions. As we examine some of the social aspects of the energy situation, we will see that it is difficult to separate social effects from economic, ecological or political effects, because all involve human beings and the way they live.

4-16. Social costs

Every action or policy has some social costs and benefits, however slight. Social costs and benefits are the negative or positive consequences that are felt by the society at large, as they affect the lives of individuals. For example, the national speed limit has been set at 55 m.p.h. (or about 90 kilometers per hour) in order to reduce gasoline consumption, since less gas is consumed per mile at 55 than at higher speeds. One social benefit of this law is the dramatic reduction of highway deaths where the law is enforced. A social cost of the speed limit is the longer time it takes to travel long distances. For truck drivers, this can mean fewer long-distance trips per week and thus less money, although gas mileage is better. The social costs and benefits of a policy must be weighed against each other.

Questions for discussion:

1) Do you favor keeping the speed limit or changing it?
2) Are there other ways to conserve gasoline or reduce oil consumption?
3) What are some of the social costs and benefits of these policies: inflating tires to proper pressure, keeping cars tuned properly, raising the price of gasoline, charging higher tolls on roads, improving public transportation, eliminating pollution controls, subsidizing research and development of alternative energy sources?
4) How might the social costs be reduced by special taxes or rebates or exemptions?

4-17. Environment and society

Social costs are closely tied to the environmental costs of some forms of energy use. Let's take the case of a large coal-burning factory in a rural town. If the factory produces smoke and air pollution which cause environmental destruction, the social costs for the townspeople might include increased medical bills, shorter lives, the need to repaint houses more frequently and the unappealing sight of smoke and grime. However, the social benefits of the factory, tied to its economic effects,

may include employment in the factory itself and in services connected to factory workers (drug stores, gas stations, etc.), support for social activities such as softball teams, medical insurance and retirement pensions, increased communication with the outside world, and a sense of pride in local products.

Questions for discussion:

1) What are the social costs of the air pollution caused by coal combustion? How could the factory be made to bear more of these costs? What could the factory do to eliminate the air pollution that causes the costs? Remember that if the extra expense for the factory of paying for social costs, of reducing pollution or of converting to cleaner energy sources is too high and makes the operations unprofitable, the factory will have to close. The factory's closing would mean the loss of its social benefits to the townspeople.

2) How might this be avoided? How might different groups (federal, state and local governments, factory owners, workers, other townspeople) be involved in working out a solution acceptable to all?

Activity:

If time allows, you may wish to design and play a simulation game based on this situation, taking the roles of factory owners, workers, the town council and others involved.

4-18. Elasticity of demand

Recall from chapter 1 the importance of energy in our lifestyles and habits. What social costs would be involved for us if energy became much more expensive? What would be the costs for others?

In order to answer this last question, and to understand the different effects of energy costs on different groups in our society, we must know:

1) the amount of energy that could be conserved without major changes in lifestyle, by, for example, insulating the house, turning down the thermostat or walking to the grocery store instead of driving, and

2) the amount of extra money the members of a group could afford to pay for more expensive energy.

These factors affect what is known as the "elasticity of demand," or in other words, the amount an individual can "bend" his needs or wants to the pressure of higher prices without drastic changes in lifestyle or finances.

The elasticity of demand for a commodity is largely determined by the nature of that commodity. In other words, if the commodity is regarded as a necessity and is perishable or used up quickly, demand will be relatively inelastic, and people will

continue to buy nearly the same amount even at higher prices. For example, if your family uses a loaf of bread a day, you will probably continue to buy about a loaf a day whether bread is cheaper or more expensive. For a non-perishable luxury item, such as a pleasure boat or a mink coat, a sharp rise (or drop) in price would strongly affect how many you bought or whether you bought any at all. Energy is most often a necessity, and is used quickly, so demand has been relatively inelastic as prices have risen. The effects of increased prices have been different for different parts of society, however.

The Ford Foundation did a study in 1973, which compared the total primary energy use in poor, lower middle, upper middle, and well-to-do households in the United States. As might be expected, the more well-off the household, the higher was their energy use. However, the differences in amount of energy used were not as great as the differences in amounts of income. This means that the percentage of income spent on energy was greater for the poorer families. (See figure 26 below.)

Figure 26: Percentage of Family Income Spent on Energy

Income Status	*Average Income*	*Average Annual Btus (Millions per Household)*	*Average Annual Cost per Household*	*Percent of Total Annual Income Spent on Energy*
Poor: Total	$2,500[a]	207	$379	15.2
Natural gas		118	147	5.9
Electricity		55	131	5.2
Gasoline		34	101	4.0
Lower middle: Total	$8,000	294	572	7.2
Natural gas		129	153	1.9
Electricity		80	167	2.1
Gasoline		85	252	3.2
Upper middle: Total	$14,000[b]	403	832	5.9
Natural gas		142	166	1.2
Electricity		108	213	1.5
Gasoline		153	453	3.2
Well off: Total	$24,500[b]	478	994	4.1
Natural gas		174	200	.8
Electricity		124	261	1.1
Gasoline		180	533	2.2

Note: Electricity and natural gas expenditures based on billing data received from utilities. Gasoline expenditures estimated from respondents' quantitative information and the average 1972–73 price of 37¢ per gallon.

[a] 77 percent of the poor had incomes less than $3,000.

[b] Calculated from unpublished census data.

Source: Washington Center for Metropolitan Studies Lifestyle and Energy Surveys, 1972–73.

from: A Time to Choose: America's Energy Future, Energy Policy Project of the Ford Foundation, 1974, p. 118.

The study also found that the lower income families used most of their energy for strictly necessary purposes such as heat and cooking. In other words, energy demand in the lower income families is the least elastic, because there is little "margin" of non-essential energy use that could be reduced in the face of higher costs. Yet while the wealthier families have more room to "bend" to higher energy prices, consumption has not been reduced. This would seem to indicate that energy uses that are not strictly necessary are nonetheless regarded as worth the extra expense. We will consider the problem of differing perceptions in the next section.

Questions for discussion:

1) Look again at figure 26. If energy supplies become short or energy prices go up, what will be the social costs for each group? How can increased pressure on poorer families mean social costs for the rest of society, if more welfare is needed or people are inadequately cared for and thus less productive in their work and more likely to turn to crime or other forms of unrest? How can increased pressure on middle and upper income families cost society, if there is less money for purchases, savings, investments or charities, increased social tension and less willingness to pay taxes to support social programs?

2) How might tax rebates, energy rationing or taxes on luxury uses of energy ease the pressure of unequal social costs?

3) Can you draw any hypotheses from this study of U.S. households that might apply to the differences between richer, middle-income and poorer nations of the world? One important difference is that energy use levels between rich and poor nations differ greatly, particularly in fossil fuel consumption.

4-19. Perceptions

The magnitude of social costs depends a good deal on how people perceive their position. If a second car is regarded as essential and not a luxury, the lack of a second car will be felt as a social cost. As expectations and definitions of the "good life" have risen in the developed countries, particularly the U.S., with improvements in technology and economic organization, the definitions of basic requirements have also risen. These definitions are not unchangeable, however, and could be adapted to less energy-intensive products and services. For example, if driving a small, efficient car becomes a sign of status at least equal to that of driving a gas-guzzling big car, then the social costs of energy policies that favor small cars will be felt to be less. If having a yearly pass on the commuter train or bus is also an acceptable and practical way of getting in to work, many people's lifestyles could become even less energy-intensive.

Questions for discussion:

1) Do you see any indications of greater popularity for energy-saving products or methods?
2) Might the increasing expense of energy make it even more of a luxury item, with greater status attached to the use of larger amounts of energy?
3) Why would it not be possible, or even desirable, to "get back to the good old days" before the conversion to coal or oil use? What are the unavoidable requirements of a larger population? For example, why might countries that must import food from the farmlands of the U.S. object to a widespread substitution of horses and plows for tractors?

4-20. Social responsibility

Going back once again to our 55 m.p.h. example, let's consider the concept of social responsibility. If energy is an increasingly expensive national resource and a source of increasing dependence on imports, what is our responsibility in efforts to conserve it? How can individual desires (getting there faster) be balanced with the common good of society (using and thus importing less oil, fewer traffic fatalities)? What would the effects on our lifestyles be if we were to reduce energy consumption. What are the energy-conservation responsibilities of government? of businesses and industry? Do you feel there is a greater awareness of or respect for a "conservation ethic"? Show evidence collected from newspaper headlines, magazine articles or advertisements, television programs and commercials, or the survey conducted in chapter 1. What is the responsibility of the U.S., if any, to the rest of the world as a major importer of nonrenewable fossil fuels? the responsibility of other importing nations? exporting nations? How great do you think is the elasticity of energy demand in the entire U.S., recalling the chart comparing per capita GNP and energy consumption in different countries, figure 22, page 45?

4-21. Society: summary questions

1) What are social costs and benefits? Why are they often difficult to measure or evaluate exactly?
2) How does relative elasticity of demand affect the social costs of higher prices? How does demand elasticity differ among income groups? What are the social implications?
3) How does social responsibility apply to the energy issue? How might definitions differ, depending on which social costs are considered most important?

4-22. Chapter 4: summary questions

1) How is the world production and use of energy a complex system? What is characteristic of such a system?
2) How are the ecological, economic, political and social aspects of energy use interrelated? How can action

in one area affect all other areas?
3) How do economic, environmental and social problems become political problems, when decisions and policies must be made?
4) How do ideas of social cost and responsibility apply on a global scale, or do they?

Chapter 4. References and suggestions for further reading.

Environmental

4-1. Firewood crisis

The American Forestry Association. American Forests. The October 1978 issue discusses the use of wood for energy and its environmental consequences.

Erik P. Eckholm. The Other Energy Crisis: Firewood. Background reading for section 4-1; a clear discussion of the problem.

Marvin Harris. "The Myth of the Sacred Cow." Recommended reading on the cow's important role in Indian agriculture.

Patricia Hughes. "The Sacred 'Rac'." Recommended reading on America's beloved, destructive beast.

4-2. Obtaining energy through 4-5. Environment: summary

Tom Alexander. "New Fears Surround the Shift to Coal." Discussion of the potential environmental damage of large-scale coal use, particularly from air pollution.

Antioch Community Schools District. Environmental Education: Values for the Future. Lesson outlines on environmental topics, including those related to energy use and production.

Exxon Corporation. "Environmental Conservation--A Progress Report." Exxon's work to reduce environmental damage in all stages of oil use.

Exxon Film Library. Catalog. Information on freely loaned films on petroleum production, environmental aspects of energy production and other related topics.

New York State Alliance to Save Energy, Inc. Energy on Film. Excellent, useful bibliography. The films listed that would be useable in sections 4-2 and 4-3 of this chapter include:

"Oil" and "Oil Well." Oil production and measures taken to prevent pollution. Free loan by Shell Film Library, 1433 Sadlier Circle West Drive, Indianapolis, Ind. 46239.

"A History of Natural Gas." Production of gas. $25 purchase from American Gas Association, 1515 Wilson Boulevard, Arlington, Va. 22209.

"Western Coal: An American Dilemma." Economic benefits and environmental hazards of coal production. $21 rental for three days, Churchill films, 662 North Robertson Boulevard, Los Angeles, Cal. 90069.

"Exploring Electrical Energy." Tour of a generating plant. $200 purchase from Donovan Films, 44 Treat Road, Box 309, Glastonberry, Conn. 06033.

Public Service Electric and Gas Company. "Energy and the Environment." Informative booklet on how PSE&G is preventing land, air and water pollution.

Lon C. Ruedilisi and Morris W. Firebaugh, ed. Perspectives on Energy. Discusses environmental risks of fossil fuel production and use.

U.S. Department of Energy. Citizens' Workshops on Energy and the Environment Handbook. Basic background information on the environmental risks of major energy sources.

_____. Energy Trails: A Guidebook Describing Energy Sites, Power Plants, Science Museums, and Other Interesting Places: Northeastern States. Guide to field trips for section 4-3.

Economic

In General:

Helmut J. Frank and John J. Schanz, Jr. The Economics of the Energy Problem. Excellent narrative and teaching suggestions.

Workshop on Alternative Energy Strategies. Energy: Global Prospects 1985-2000. Good background reference; lots of economic data.

4-6. Energy and the economy

Edison Electric Institute. "Economic Growth in the Future." Connects energy and economic prospects.

Executive Office of the President. The National Energy Plan. Analyzes the economic impact of energy policies; source of graph in figure 22.

4-7. The oil cartel

Interact. "Enterprise--A simulation of the American capitalistic system." Simulation game for domestic economics.

_____. "Trade: A simulation of the pressures and procedures of international commerce." Good simulation game for international economics.

Craig S. Karpel. "Ten Ways to Break OPEC." Economic and political strategies.

Louis H. Lapham. "The Arabian Oil Bubble." The need to do something besides blaming everything on OPEC.

National Science Teachers Association. "Energy in the Global Marketplace" and "An Energy History of the United States." Lessons and data on energy, including data for figures 23 and 24.

Staples Energy Conservation Program. Staples Energy Conservation Program. Outlines for lessons on energy economics including "Economic System" simulation and elasticity of demand.

Western Publishing Co., Inc. "Economic System." Simulation of economic interdependence.

4-8. Price increases and the economy

"Inside the Big Oil Game." Time. May 7, 1979 article about price policies and effects.

4-9. Energy and agriculture

Ag World. Periodical which relates agriculture to topics such as energy, economics, international relations, etc.

Jo Anne Buggey and June Tyler. The Energy Crisis. Source of cartoon, figure 25.

4-10. Adjusting to higher prices

Committee for Economic Development. International Economic Consequences of High-Priced Energy. Advanced reading.

Godfrey G. Howard. "A Second Look at Inflation." Another somewhat advanced reading.

4-11. Developing countries

Denis Hayes. Energy for Development: Third World Options. Appropriateness of renewable resources for developing countries.

James W. Howe. "Energy and Developing Countries." The economic problems caused by high-priced energy in developing countries.

Anthony Pearce-Batten. "The Future of Renewable Energy." Need for renewable energy development in developing countries.

Simile II. Starpower. Game simulates inequities of a three-tiered, low-mobility society. Aids in understanding Third World problems and perspectives.

Political

4-13. Oil politics

Foreign Policy Association. Great Decisions '78. Article and discussion questions on the implications of the energy situation for American foreign policy.

John C. Sawhill, Keichi Oshima and Hanns W. Maull. Energy: Managing the Transition. Interrelations of U.S., Europe, Japan and Canada.

Vivian Lewis. "Europe's Oil Imbroglio." European relations.

Daniel Yergin. "The Real Meaning of the Energy Crunch." Relations between the U.S., OPEC and the Soviet Union.

4-14. Nuclear politics

Committee for Economic Development. Nuclear Energy and National Security. Global nuclear development and the U.S. role.

Dan Cook. "How Carter's Nuclear Policy Backfired Abroad." International resentment of the U.S. position on nuclear development.

Social

4-17. Social costs through 4-21. Society: summary questions

Center for Ethics and Social Policy. Ethics for a Crowded World: A Seminar Series. Discussion of ethical implications of the energy issue; companion reading to section 4-20.

Energy Policy Project of the Ford Foundation. A Time to Choose--America's Energy Future. Good discussion of social costs, source for narrative and graph (figure 26) in section 4-18.

CHAPTER 5. WHAT IS BEING DONE?

We have studied the history of the energy problem and aspects of the current energy situation; let's now look toward the future. Because the present energy problem is one of increasing demand for limited fossil fuel supplies, we have three major alternatives for action now and in the future:

1) reduce demand through conservation
2) increase production of fossil fuels
3) develop alternative, and preferably renewable, sources of energy

In this chapter, we will examine these alternatives for energy supplies and demand and their advantages and disadvantages--ecological, economic, political and social. There is a good deal of information available from various sources, including the U.S. Department of Energy and the oil and utilities companies, on the technical feasibility of various alternatives. Therefore, this chapter will serve simply as a guide to questions, topics and resources for research and discussion, rather than as a narrative on the various energy alternatives. Your teacher will probably ask you to research the basic information for one of the alternatives and present it in an oral or written report.

5-1. Conservation

Because much of our energy-intensive way of life was developed while energy was cheap, many of our methods and products could be redesigned to use less energy. One reason for the strong performance of some European industries in conserving energy, for example, is the fact that many factories were replaced or rebuilt after their destruction in World War II and equipped with newer methods or machinery which conserved more energy. Energy can be conserved as old factories, houses, cars or appliances are replaced by more efficient ones, but the improvements must wait until the older things need replacing, or else be very expensive. Different products have different turnover rates, or rates of replacement. It takes about ten years, for example, to replace nearly all the cars on the road with newer models. It usually takes much longer to replace a neighborhood of houses with newer ones.

But not all conservation requires replacement. Parts can often be added, removed or improved without total replacement. For example, insulation can be added to an existing house, lights can be turned off, and driving habits can be changed to save energy with what we now have.

Questions for research and discussion:

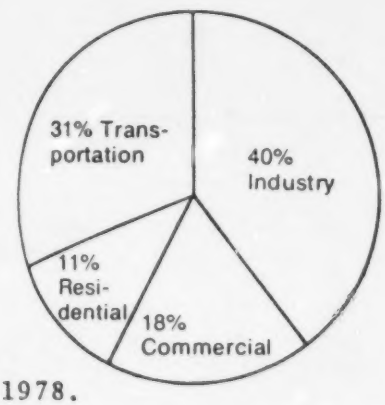
1) Examine figure 27. (These statistics are for the U.S. and may differ somewhat from those for other industrialized countries, particularly in the area of transportation.) Which are the primary fuels for each sector? How could energy be conserved in each sector? How could energy be conserved in the major areas of use--heating and cooling, heating water, transportation, lighting?

2) How can conservation be accomplished by reducing energy demands, as in turning down thermostats? by increasing efficiency, as in installing insulation?

How can recycling products conserve energy? save money? help the environment? What products can be recycled? Consider the less obvious ways, such as handing on old clothes or using the material for other purposes, maintaining an older car instead of buying a new one, using and replanting live Christmas trees.

3) How could energy-saving techniques and products be made available to other countries? What other countries have conservation technology that might be adaptable or useful in the United States? If there is an exchange student in your class or school, you might ask him or her to compare everyday energy use in his or her home country and the host country. Are there any conservation ideas that could be put to use in your town? How does the spread of conservation technology benefit all?

Figure 27: U.S. Energy Use by Sector



from: The Energy Challenge, Federal Energy Administration, 1978.

4) What are the advantages of conservation as an alternative for future energy policy? the disadvantages? Consider environmental effects, economic and social costs and benefits, political feasibility.

Activities:

1) Using the information gained in the energy use survey in chapter 2, compile a list of conservation suggestions, including recycling, for your home, school or town. Your initial list may include everything from the easiest to the least likely--be thorough and imaginative. Then, devise a practical, step-by-step program for your home (or dorm), your school or your town. If possible, indicate the rough amounts you could expect to save. Present these plans to your family, school administrators or town officials, and ask for their opinions, evaluation and support. Discuss costs of implementing your suggestions and compare possible savings on energy bills. Choose suggestions to implement. Discuss and plan ways to enforce or maintain the selected ways to conserve. If possible, do a follow-up energy use survey after conservation has begun, to determine its effectiveness and acceptability to fellow family members, classmates or neighbors. You may wish to keep your school or local newspapers informed of your activities. Another suggestion is to consider working with local community service organizations.

2) What energy conservation laws exist in your state or town? Contact your state energy department or the related authorities to find this information. New Jersey, for example, has a law that commercial buildings set maximum heating temperatures of 68° F when the building is in use, and 55° F when it is not occupied. How were these laws enacted? made known? enforced? How effective have they been? How can they be changed? Are there new laws being considered? How could you try to influence their passage or rejection?

What incentives does your state offer for energy conservation? You may also want to explore the federal tax credits and other incentive programs. Could any of these apply to your home, school or town?

5-2. Fossil fuel production

As we have pointed out elsewhere, the amount of fuel that can be extracted from a given site depends on the current price of fuel versus the cost of extracting it. If fossil fuel prices continue to rise, it will become profitable to "squeeze harder" existing resources and to explore other areas or kinds of fossil fuel resources. This alternative may seem the "easiest," because the distribution systems, infrastructures and current production techniques are based on fossil fuels. Increased production would mean less change and dislocation for our fossil fuel-based economy, and particularly for the oil companies.

There is a great deal of information and expertise available on fossil fuels from the oil and energy companies, as well as the utility companies. Write to them for materials and possible speakers or field trips; they are often eager to inform a largely unaware public of the efforts and work behind the energy we take for granted. A field trip or movie of a drilling rig, refinery or mine can help you understand what is involved in obtaining fossil fuels.

Questions for research and discussion:

1) Oil. How is oil produced? What is secondary recovery? Where are new sources of oil being found? Where are offshore oil wells located? How do the number and types of refineries affect amounts and types of oil available?

2) Gas. How is gas produced? Why is gas sometimes "flared off" at wells? What are the advantages and disadvantages of natural gas? of liquified natural gas (LNG)? Where is gas being produced? Where are new sources being found?

3) Coal. What share of total energy does coal now provide? How do the size and location of coal reserves compare with those of oil and gas reserves? What are the ecological and economic problems posed by underground and strip mining? by the increased combustion of coal? How do these become political problems, for example in the American West, where some coal and oil shale deposits are located under reservations belonging to Native Americans?

4) Synthetic Gas and Oil. It is possible to produce a type of oil and gas from coal. Recalling the second law of thermodynamics, how would this conversion process compare in energy efficiency to the direct use of coal? What are its advantages in terms of shipping and end use in existing facilities? in terms of environmental quality? Is this process now economically feasible?

5) Other Sources. What is oil shale? Where is it located? What technological and ecological problems are connected with mining it?

6) What are the political advantages and disadvantages of increasing fossil fuel production? How might continued purchase of Arab oil give oil-importing countries a measure of political influence in the troubled Middle East?

What are the environmental, economic and social advantages and disadvantages of increasing fossil fuel production? Increased fossil fuel production is an appealing option because the interest and research of the oil companies are focused in that direction. Why must interest in this option be balanced with the need to research less conventional energy alternatives?

5-3. Energy alternatives

Fossil fuels are currently the primary source of commercial energy, but they have not always been so, nor will they likely remain so for more than the next few decades. There are other

sources of energy now being used or explored, which will have to be developed further, so as to provide a larger share of our energy demand.

With each alternative energy source, there are advantages and disadvantages to their production and use. Most are renewable; nuclear energy is one exception. If the lessons of the consequences of fossil fuel dependence have been learned, the future energy situation will probably not be characterized by reliance on one source alone, but by the use of a diversity of energy sources, most if them renewable or abundant.

A. Nuclear fission and fusion

Nuclear fission, the atom-splitting reaction which is the basis for nuclear weapons, can be harnessed to produce large amounts of electricity and heat from a scarce form of uranium, available in less than 1% of common ore. Nuclear fusion uses deuterium, which is available from water, to fuse atoms and produce energy. Although a fusion reaction occurs in the explosion of a hydrogen bomb, a fusion reactor would not produce materials that could be used in making bombs and would run no risk of an explosion due to an uncontrolled reaction. Fission reactors are already in use in a number of countries, but a sustainable, controllable fusion reaction has not yet been achieved anywhere.

1) What are the major types of fission reactors? Where are they now being used? Which are used most widely? Where does the fuel come from? How available is it, and how long will it last? What is a breeder reactor? Why are countries interested in it? Why do breeder reactors require more security safeguards?

2) What are the dangers involved in shipping, reprocessing or storing reactor fuels and wastes? What countries are involved in these processes?

3) What countries are working on nuclear fusion research? Why is it a desirable alternative? If the scientists were to achieve a successful fusion reaction today, how long would it require before commercially-produced fusion reactors could be hooked into existing electrical networks?

4) Because nuclear reactors produce large amounts of electricity, energy production becomes centralized in one location. What are the advantages and disadvantages of centralized production over a number of smaller, local energy plants? Why would nuclear plants need tighter security than other power plants to avoid sabotage or the theft of radioactive materials?

5) Nuclear technology is quite advanced and requires highly-skilled designers, operators and workers. The construction costs of a nuclear plant, with its complex engineering and safety systems are very high, and a country must have access to uranium ore and waste storage sites. If these factors are added to the requirement for large-scale, centralized electrical networks, nuclear energy appears unfeasible or at the least uneconomical for those

developing countries with largely rural, widely distributed populations and little wealth. Some developing countries, however, are very interested in nuclear energy. Why do you suppose, for example, India is interested in developing its nuclear energy capabilities? What are the risks and benefits of the international exchange of nuclear energy technology?

6) We discussed the political aspects of nuclear energy in chapter 4 (section 4-12). What are its economic, ecological and social benefits and disadvantages?

B. Solar energy

Solar power is our oldest and, indirectly, largest source of energy, and, like related renewable energy sources such as wind power, it has several characteristics different from fuels such as oil or wood. It is available everywhere on earth, though not always in usable amounts, and it must first be converted to some other form, usually electricity, before it can be transported to other locations. The two major uses of solar energy are heating and electricity.

The heating potential of solar power has long been known to man. In the past, most solar heating has been passive, i.e. by positioning the house or materials to use existing sunlight, without concentrating or storing it. Active solar energy involves concentrating or storing it. The generation of solar electricity, for example, requires the active use of solar energy.

1) The amount of solar energy available differs from place to place. Obtain a map of solar energy zones, and locate your area on it. Which regions of the world would be best suited to solar energy use?

2) Project. Design and landscape a house or other building to make maximum use of passive solar energy in a moderate to cool climate region. How would you position the house? Where would you put the larger windows? What colors would you use? Where would you plant evergreen trees or shrubs? deciduous summer-shade trees? Design a passive solar powered clothes dryer (there are many around). What can you use to increase the effectiveness of your passive solar system, such as greenhouse additions, reflective or absorptive sheeting, water barrels, etc.? You might also want to design a building for a tropical zone, where solar energy absorption would need to be minimized. How do the buildings characteristic of sunny countries, such as in North Africa, provide examples of this design?

3) What are the available active solar energy systems for heating water? heating buildings? How is solar energy concentrated or stored in these systems? What is a heat pump? How does it increase the usefulness of a solar energy system? Because of the limited hours of sunlight and its seasonal variations outside the equatorial zones, solar heat energy is often not available when it is most needed,

as on cold winter nights. The storage of heat in water or rocks or whatever is one approach; another is the use of solar energy in conjunction with conventional systems, to serve as a back-up or booster. In these cases, the available solar energy is used to pre-heat the water or air, so that less conventional energy is spent bringing it up to normal heat levels.

4) Why does solar heating necessarily mean decentralized, local units? How does this make it appropriate for household use? Why might utility companies be less interested in this aspect of solar energy? What are the economic and social advantages and disadvantages of building your own solar heating system over using gas or oil purchased from a supplier?

5) Project: Design, build and use a solar cooker. How effective is it? What are its drawbacks? When during the day would it be most effective? Is this the usual dinner or supper hour? You may be interested in learning more about the solar blast furnace at Odelle, France. How is it similar to your solar cooker?

Alternate Project. Build a solar food dryer. What is the advantage of dried foods? How effective is the solar dryer? Would either of these devices be useful to you? Why or why not?

6) Optional Research. How does a solar electric cell work? What are the current hindrances to its wider use? Why would the centralized generation of solar electricity require large land areas? How might satellites, ocean-based stations or raised mirrors allow for efficient electrical generation without disrupting current land use? How expensive might these options be? You may wish to study further one of these options, reading current research and opinions and exploring the possible economic, environmental and political questions involved.

7) Solar energy may prove most economical for rural areas, particularly in developing countries, where other energy sources are more expensive because of the lack of an existing infrastructure of power lines, pipelines, or tanker-truck routes. How can solar energy be used in these or other areas for desalination of water? drying crops before storage (currently done with natural gas in the U.S. Midwest)? running pumps for irrigation of fields? How might the use of solar energy in agriculture increase unemployment in rural areas? How might it help reduce fossil fuel imports?

8) What are the advantages and disadvantages--economically, politically, socially and ecologically--of solar energy use? Are they different for solar heat and solar electrical energy use?

C. Hydroelectric power

There are many hydroelectric plants in use today, some of which were built more than 50 years ago, and water power in the form

of mills on rivers dates back many centuries. Most of the major sites in the industrialized countries have already been utilized, though there are possibilities (if the technology and economics are improved) for many more smaller, local hydro-plants. It is primarily in the developing countries, particularly the mountainous ones, that the potential for hydroelectric power has not yet been fully realized.

1) How does a hydroelectric plant work? What are the ecological advantages of hydropower? How can the dam required for hydroelectric generation put pressure on the local ecology above the dam? below the dam? as a barrier to the movement of wildlife across the dam?

2) What are the economic, social and political advantages and disadvantages of diverting water to produce large amounts of centralized electricity, of creating a lake and of reducing or controlling water flow downstream, especially in agricultural economies?

3) What were the effects of the Aswan High Dam in Egypt? You may want to choose this or another large hydroelectric project as a "case study" of the advantages, costs and often unexpected consequences of major dam building. Other examples could include the Itaipú Dam on the Paraná River between Brazil and Paraguay, or the Kariba Dam between Zambia and Zimbabwe Rhodesia. How have other nations been involved in advising, providing aid or utilizing the resultant energy? How successful have the Chinese been in using small-scale dams to provide local power in rural areas?

D. Wind energy

Wind energy is another familiar source of renewable energy. Windmills can produce mechanical energy for tasks such as pumping water or grinding grain, or the rotation of the blades can be transferred to an electrical generator.

1) What areas can best use wind power? What is the advantage over solar power during stormy winter months? How can too much wind be dangerous? Why were many of the old windmills in Holland or on the American Great Plains abandoned earlier in this century?

2) What are the limitations on the size and electrical generating rate of windmills? How does a verticle-shaft wind generator compare to a horizontal-shaft one? What is the average output of a windmill? How many kilowatt-hours does the average household u[illegible]? (Use data from energy use survey, chapter 2.) What could be done with extra electricity generated on windy days?

3) What are the environmental, economic and social advantages and disadvantages of wind power? How might widespread use of wind or solar power cause conflicts over the wind or sunshine rights of neighboring buildings? Why would wind and solar energy be less useful alternatives in large cities or densely populated areas?

E. Ocean energy

Energy can be derived from the ocean's tides, waves or thermal layers. Geographic location is critical to the generation of electricity from tides. Within a certain range of latitudes north or south of the equator, there are some harbors and inlets that experience very great differences between high and low tides, such as the Bay of Fundy in Canada. As with hydroelectric plants, the water is stored up behind a dam, then released (either out to sea or into the bay) to drive turbine generators.

Wave-generated power has not yet been perfected for practical uses but would be widely available on the world's seas and seacoasts, particularly in stormy winter weather.

Ocean thermal gradient power lies in the difference in temperature between warm surface layers and cold, deeper layers of water. It, too, needs to be made more economically feasible before it can be used on a large scale, and would be more suited to some ocean areas than others.

1) There are only 2 major tidal power stations in operation; one in France and one in the Soviet Union. Why is tidal power not likely to be one of the major world energy sources at its current technological level? How might the development of small-scale hydroelectric equipment for streams and rivers encourage the wider use of tidal power?
2) How is wave motion converted to electricity? How would an ocean thermal gradient station produce electricity? Are these methods technologically feasible as of yet? economically feasible?
3) What ecological problems might occur to marine and coastal life, if tides, waves and water layers were harnessed for energy use? What are the ecological benefits over fossil fuel combustion?
4) What social and economic advantages and disadvantages might occur for seacoast areas? How might obtaining energy from the ocean ease land-use pressure on shore?
5) How might political conflicts arise over the energy potential of the world's oceans? How would landlocked nations react? nations without the technology to extract energy? An indication of political reactions may be found in the current negotiations over rights and exploration of the ocean's mineral and food resources. Why is global cooperation critical in this area?

F. Geothermal energy

Geothermal energy is another renewable resource which will probably be a supplemental, rather than a primary source of energy, because it is limited to appropriate geographic locations. It involves the use of heat trapped in rocks or liquids below the surface of the earth, either directly or in the generation of electricity by steam.

1) Geothermal generating stations are located in California, and in Italy, Iceland and New Zealand. Where are

other potential sites? How do "wet steam" sites differ from "dry steam" sites?
2) What ecological and social problems can be caused by pumping up hot sulfurous brines? by disturbing underlying geological formations? What types of energy consumers might best be located near a geothermal plant?

G. Energy from biomass or Organic materials
This category of energy sources is large and varied, and familiar to humankind since the discovery of fire. Wood is a traditional, organic, renewable fuel, but there are others, including peat from Irish bogs, buffalo or cattle dung on the Great Plains of North America or in India, and the husks and stems left after crops are harvested.

Organic fuels can be burned directly or converted to other forms, particularly alcohol or methane gas.

1) What is gasohol? How can it reduce oil imports? How can it be used in existing engines? in specially designed engines? How is Brazil developing gasohol production? How successful have their efforts been? How might energy derived from crop residues be particularly appropriate to many other Third World nations?
2) What are biogas converters? What are their products? How do they address both energy and fertilizer needs? How are they being used in China? How might the converters be appropriate in densely populated, agricultural communities? How can they help solve the ecological problems of sanitary waste disposal? How would cattle pens, barns or stockyards be more efficient for waste collection than pastures or open range?
3) Project. Build a methane gas generator. (It may prove easier than getting permission to build a still for alcohol.) Dried manure can be obtained at most gardening stores. You may wish to experiment with different sources of organic waste. Compare the BTU value of the energy obtained with the energy value obtainable from direct combustion of the materials. What is the agricultural value of the material left after gas has been generated?
4) What are energy plantations? What types of trees are most suited to this use? How might the use of land for energy production instead of food production cause economic, social and political problems? How energy-efficient are most fireplaces? How could they be improved? How efficient are wood stoves or burners?
5) Name some of the cities that use waste-conversion plants to produce heat and electricity. What special trash collection and sorting methods does this require? How has it helped solve the problem of overfilled dumps and polluted rivers? Which is the more efficient or the more practical use of energy from burning municipal trash--heat or electricity? How do some European cities use district heating

plans? What might be some of the social disadvantages of building houses near the waste-conversion plants, so as to use the heat produced?

6) What are the ecological benefits of energy from organic materials? What are the limitations of using renewable fuels? (Recall the lesson in chapter 3, 3-1.) How might diverting manure and crop residues to energy use have ecological disadvantages in agricultural areas? Recalling the discussion of the "firewood crisis" in chapter 4, what potential ecological hazards lie in over-dependence on and use of renewable resources?

7) How might social, economic and political questions arise over who profits from energy derived from organic wastes, how much energy is produced, and where this energy is used?

H. Energy storage and transfer

A major problem in the use of renewable fuels, particularly in producing electricity, is the storage and transfer of energy from the production site to the site of consumption. Storage is also critical, unless back-up fuel systems are available, for energy sources which, like solar, wind or tidal energy, may occur sporadically or fluctuate seasonally. Storage usually involves the conversion of electrical energy to potential energy in the form of chemical bonds, as in a battery, or in the form of stored mechanical energy, as in water pumped up to a reservoir above the generators. Once again, the second law of thermodynamics reminds us that the conversion or transmission of energy entails losses in energy efficiency. But less energy is better than no energy at all, if the surplus cannot otherwise be used.

1) How do batteries work? What are other possibilities for the storage of electrical or heat energy? How efficient are they? How transportable? What are the time and size limitations on these energy storage methods?

2) What are the current areas of research into materials or methods, such as super-cooling, that could increase transmission efficiency? What are base loads and peak loads in electrical usage, and how do they affect needs for energy storage and transmission and for controllable sources of electricity?

3) How could efficient storage and transportation of energy make the use of renewable resources more economical? Nations with large quantities of such resources would be able to export their energy, as countries with fossil fuels do now. Give some examples of countries that could export renewable energy, such as the export of wind energy generated by monsoons or typhoons in Burma or India.

4) What might be the ecological and social benefits of separating energy-producing plants from residences and businesses? What might the price be in economic and efficiency costs?

5-4. Chapter 5: summary questions and activities

1) What are the major advantages and disadvantages--ecological, economic, political or social--of easing the energy problem through:
   a) conservation,
   b) increased production of fossil fuels,
   c) use of alternative energy sources?

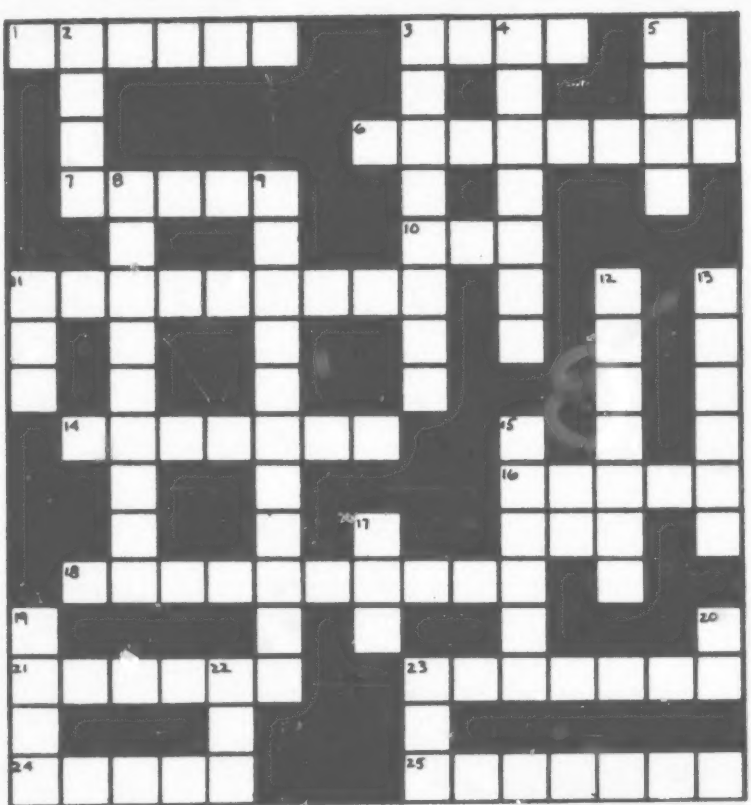
2) What conservation techniques or alternative energy sources would be applicable to your school? your house?

3) Which of the alternative energy sources seems to you to offer the best possibilities for the future? What are their major advantages and disadvantages? Why is it unlikely that any one of these sources will be sufficient by itself? How might different countries and different regions within countries use different mixes of energy sources? How would agricultural regions, for example, require and be able to use different types and amounts of fuels?

4) How might world political tensions be eased if countries were to use more of their indigenous, renewable resources in place of fossil fuels? How might they be increased if nations dispute over energy from rivers, oceans, etc?

5) Describe your vision of the world's energy future and situation 10 years from now. 100 years from now.

6) Fill in the crossword puzzle below. When you've completed it, check your answers with those in the answer key, Appendix I, page 105.



ACROSS:
1. _____ fuels were formed over long periods of time from plants and organic matter.
3. By 1885, _____ had replaced wood as the primary energy source in the U.S.
6. The portion of the total resources of a fuel which can be recovered under existing economic conditions, with existing technology.
7. Oil in its natural state.
10. Agency established after the 1973-4 oil embargo to formulate emergency oil-sharing measures.
11. Petrochemicals are used in the manufacture of_____ fabrics, such as polyesters.
14. Amount of heat needed to raise the temperature of 1 gram of water 1° Centigrade.
16. _____electric stations use water power.
18. Petrochemical product used in agriculture, especially with new high-yield strains of rice and wheat.
21. _____ can neither be created nor destroyed in physical and chemical reactions.
23. Source of fuel which includes wood, organic waste, crop residue.
24. Liquified natural gas and oil are often stored in _____.
25. Fuel for nuclear fission reactors.

DOWN:
2. Cartel of major oil-producing countries.
3. Energy stored in molecules, as in food or fuels.
4. The U.S. Congress has set standards for the _____ gas mileage of cars sold by U.S. auto companies.
5. Matter that contains energy concentrated enough to have high power when released.
8. _____ resources include wind, solar, and tidal power.
9. A secondary source of energy, produced in a variety of ways.
11. Source of almost all the energy we use.
12. Type of nuclear fission reactor under development which produces more fissionable fuel than it consumes.
13. Type of nuclear reaction.
15. _____dynamics.
17. Source of 95% of energy used in transportation.
19. Produced in any energy conversion.
20. World's largest food exporter (abbreviation)
22. Cleanest-burning fossil fuel.
23. Amount of heat needed to raise the temperature of one pound of water 1° Farenheit (abbreviation)

Chapter 5: References and suggestions for further readings

In general: (Materials which cover conservation, fossil fiels and alternative sources)

National Science Teachers Association. Factsheets. Very good, brief summaries of the technology, environmental impact and further references on conservation, fossil fuels, alternative energy sources and energy storage. A basic reference.

Lon C. Ruedisili and Morris W. Firebaugh, ed. Perspectives on Energy. College-level text with articles on fossil fuels, alternative sources and conservation with attention to the environmental aspects. Good graphs.

H. Stephen Stoker, Spencer L. Seager and Robert L. Capener. Energy from Source to Use. Another college text with a broad range of information, graphs and reference suggestions.

U.S. Department of Energy. Citizen's Workshops on Energy and the Environment Handbook. Booklet of bare basics on fossil fuel, conservation and major alternative sources.

U.S. Department of State. The United States and World Energy. Survey of energy sources available to the U.S.

Workshop on Alternative Energy Strategies. Energy: Global Prospects. The data and graphs on the global situation for fossil fuels, alternative sources and conservation. A basic reference.

5-1. Conservation

Federal Energy Administration. The Energy Challenge. Source of graph for figure 27.

New Jersey Department of Energy. Energy Exchange. Newsletter on state energy projects and policies. The toll-free number in New Jersey for information on state laws on energy conservation is (800) 492-4242. Contact your state government's Department of Energy for similar information.

U.S. Department of Energy. Tips for Energy-Savers. Booklet of practical suggestions for energy conservation.

5-2. Fossil fuel production

For information from the fossil fuel and utility companies, or from groups concerned with alternative energy sources, see the "Organizations" section of the Bibliography for names and addresses.

Tom Alexander. "New Fears Surround the Shift to Coal." Environmental disadvantages to increased coal use.

American Gas Association. "Educational Services Energy Newsletter." Information on natural and synthetic gas production.

American Petroleum Institute. "Facts About Oil." Informative booklet.

Battelle Memorial Institute. "Energy Perspectives." Good summaries of various energy sources.

Norman Cousins. "Growing Your Own Fuel." Article on alternative sources with interesting discussion of improved techniques for secondary recovery of oil.

Enercom. Energy Sources 78/79. Overview of energy companies and business. Good source of places to write for more information.

Exxon Film Library. Catalog. For films on petroleum production.

William K. Stevens. "Shell Juggles Molecules at its Louisianna Plant." Oil refining.

5-3. Energy alternatives

In general:

Denis Hayes. Rays of Hope: The Transition to a Post-Petroleum World. The movement from dwindling fossil fuels and risky nuclear power to abundant renewable resources.

Public Service Electric and Gas Company. "The Energy Outlook." Brief review and evaluation of energy alternatives.

The United Nations Educational, Scientific and Cultural Organization. The Unesco Courier. June 1978 issue is on international development of energy alternatives.

A. Nuclear fission and fusion

Committee for Economic Development. Nuclear Energy and National Security. Political aspects of this energy alternative.

Gary Hammerstrom. The Hazards of Nuclear Energy: A Policy and Planning Approach. Nuclear reactors of different types and their hazards.

Anthony J. Parisi. "Nuclear Power: The Bottom Line Gets Fuzzier." Economic aspects of this energy alternative.

Plasma Physics Laboratory, Princeton University. Information Bulletin. Information on current research into nuclear fusion.

U.S. Atomic Energy Commission. "Nuclear Power Plants." Informative booklet.

B. Solar energy

Agency for International Development. Agenda. Appropriateness of solar energy alternatives for the Third World.

Carrier Corporation. "Putting Solar Energy to the Test." Information on current solar technology.

Center for Renewable Resources. Solar Energy Education Bibliography. Publications and audio-visuals on solar and renewable energy.

Center for Teaching International Relations. Teaching About Energy Awareness: 33 Activities. On page 75, design for a solar hot-dog cooker.

Denis Hayes. The Solar Energy Timetable. Summary of need for solar and renewable energy development.

Anthony Pearce-Batten. "The Future of Renewable Energy." Article on appropriate energy technologies for developing nations, and summary of the most practical.

H. Stephen Stoker, Spencer L. Seager and Robert L. Capener. Energy from Source to Use. On page 273, a map of solar energy zones in the U.S.

C-H. Other renewable energy sources and energy storage

American Forestry Association. American Forests. October 1978 issue on biomass, "Wood for Energy."

Division of Conservation Research and Technology, ERDA. Write for information on fuel cells.

Erik P. Eckholm. The Other Energy Crisis: Firewood. Environmental aspects of the use of biomass energy sources.

Lawrence W. Latour. Inquiry Experiences in Geography. Pages 137-139 are an analysis of the hydroelectric project at Aswan High Dam in Egypt.

Massachusetts Audubon Society. Energy Packet. Basic articles on renewable energy sources, and bibliographies on wind and solar energy.

Ronald Smothers. "L.I. Town a Pioneer in Recycling Its Garbage into Electric Energy." Comprehensive description of this waste conversion project.

Carol Hupping Stoner, ed. Producing Your Own Power: How to Make Nature's Energy Sources Work for You. Guide to building small-scale, renewable energy devices, including methane gas digesters and solar space heaters.

CHAPTER 6. MAKING CHOICES

The world's energy future depends on decisions and policies made today. Because energy is a complex issue of global significance, energy policies must be designed carefully with regard to their possible effects in all areas of life. No policy will be perfect and none will be without costs of some sort, but basic priorities must be determined, and overall costs and benefits carefully weighed. The important characteristics of an energy policy are consistency, flexibility and attention to long-term implications, whether the policy is international, national, local or individual.

We shall analyze some of the factors that influence policy formation, then look at the policies of several different nations, before examining more closely the U.S. national energy policy and how it is formed. We will close this chapter and Energy in an Interdependent World, with a look at the necessity and possibilities for international cooperation on the global energy issue.

6-1. Setting priorities

Priorities and plans are necessary in order to balance immediate needs and desires with long-term goals, and to balance individual wants with the needs of the larger group. Because there are seldom enough resources to satisfy every desire fully and easily, the differing interests of the groups or individuals involved must be considered and worked out, and resources must be budgeted so as to gain the most benefits from the limited amount available.

Questions for discussion:

1) How are priorities established in any country? How does the form of government affect this process? How can the mass media encourage public participation in this process?

2) How are a country's policies affected by events and decisions in other countries? For example, how do U.S. energy policies affect Europe and Japan? the OPEC countries? the Third World?

6-2. Budgeting resources

Budgeting and planning are particularly important in the energy issue, because:

a) large amounts of capital are needed immediately for

some energy options, such as nuclear power or solar electricity;
b) the time between initial expenses and the actual operation of most energy plants or sources (or "lead-time") is relatively long;
c) we must prepare now to face a dwindling fossil fuel supply.

Questions for discussion:

1) How do energy alternatives (including conservation) compare, roughly, as to the amount of money that must initially be invested? The initial investments of "front-end costs" of a project include designing new technology (if necessary), materials involved, construction costs, training costs for personnel and, if needed, costs of establishing distribution systems (pipelines, high-tension wires, etc.) The capital for the front-end costs of energy projects may be obtained from government taxes and revenues, private business, public bond holders, bank loans, loans from other governments or international agencies such as the World Bank.

2) The speed with which front-end costs are repaid depends on the lead-time of a project. What are the approximate lead-times for commerical plants using the various energy alternatives outlined in the last chapter? What are the lead-times for various conservation alternatives?

3) Why are energy policies urgently needed by the major fossil fuel-importing nations? by the developing nations whose fossil fuel imports are beginning to increase? by nations whose economies are now dependent upon fossil fuel exports?

Activities:

1) For furtner research. Write to the World Bank for information about their loans to developing countries for energy projects. What types of projects were funded in the past? Why did the World Bank recently decide to help finance fossil fuel exploration in the developing world? Why are successful energy projects essential to the economic strength and growth of a country?

2) To put budgeting, front-end costs and lead-times on an individual level, plan and budget an energy project for your home or school, involving either conservation (for example, installing insulation and storm windows) or alternative sources (installing a solar water heating system or a windmill). From suppliers, find out the initial costs. How would you pay for these? You might want to ask a bank officer to describe loan procedures for these sorts of things. How much energy would be saved

or produced? How much money would be saved, at current fuel costs? How long would the project take to pay for itself? for the interest on the loan? How long would it take if fuel prices went up 2% a year? 5%? Is this project economical in the long run? What other benefits and costs might it have, besides purely economic ones?

6-3. Economic growth

Closely related to the concerns about choosing how to invest limited present capital for tomorrow's needs is the concern for economic growth and stability. Choosing to invest money, labor and resources in energy projects means not having it to invest elsewhere, and future economic growth in any sector depends on investments made in the present.

Questions for discussion:

1) How have economic welfare and energy use been related in the past? (Refer to figure 22, p. 45.) Reducing energy consumption will most likely slow economic growth. Why does a slowdown in economic growth cause problems, especially when combined with continued growth in population? How are increases in jobs, earning power and tax revenues linked to economic growth? Might an economic slump be balanced by new industries and jobs based on energy alternatives, such as solar panels, windmills, electric cars, heat pumps, etc.?

2) How would a sharp or sudden energy shortage endanger economic stability? How might a sudden shift to new energy sources cause economic instability? Why is an orderly transition period important? How can it be achieved?

3) What economic problems might arise with the diversion of investments from agricultural and industrial development? How do these problems compare with those that would result from energy shortages, if energy investments are insufficient?

4) How are the economies of the industrialized nations and the developing nations linked? How does growth in one group aid the other? Why might it benefit the industrialized countries to aid developing countries in establishing energy policies and facilities?

6-4. Political stability

Closely related to economic stability and growth, and in many cases dependent on it, are internal political stability and external security. Internal problems of social discontent and possible political unrest may be posed by diverting money from social programs, such as education or health care.

External security may also be weakened if investments are diverted to other programs, but dependence on other countries for energy imports is another potential security risk. While independence from outside sources of energy would be difficult to

achieve, as few nations can provide for all their various energy needs, a nation can diversify its sources and types of energy imports to avoid over-dependence on any single one.

Questions for discussion:

1) How can the controller of a nation's energy supply influence a nation's economy? its military security?
2) We have addressed the issue of political stability from the importer's point of view. How is the formation of a far-sighted energy and economic policy critical to the political stability of an oil-exporting nation? What will happen to these countries when oil supplies begin to run low? How are oil-exporters dependent on the continued ability of importing countries to pay oil prices?

6-5. Environmental quality

Although ecological sciences are relatively new, environmental stability and quality are now recognized as important in planning policies, particularly energy policies, on both the national and international level. Planning must balance short-term with long-term environmental effects, because unchecked damage to the environment can cause losses that are impossible or very costly to recover.

Questions for discussion:

1) Environmental concerns are closely linked to economics. How is a nation's environment a source of economic resources? How is the health of a nation's work force an economic resource? How is this true on a global scale? Who pays the costs for pollution of the air, water and land in health bills, clean-up bills, sewage and waste treatment bills, etc.?
2) How can a government balance long-term environmental concerns with shorter-term economic concerns? with a concern for developing national energy resources to reduce dependence on imports? How does the choice of energy sources determine the kinds of environmental problems that arise?

6-6. Social effects

The social effects of energy policies are a necessary consideration. If a policy weighs too heavily on one group, such as the poor or one area, such as urban centers, it will be unstable and a possible source of discontent. Social discontent may be expressed as political opposition to the makers of the policy, as anti-social acts such as strikes and riots or as simple non-compliance with energy laws. None of these are desirable to the policy makers, if they reduce the policies' effectiveness or threaten the policy makers' position. Thus, energy policies are usually designed so as to be acceptable to the public or, as is often the case, acceptable to those segments of the public that can wield political power.

Questions for discussion:

1) How can policies such as offering tax rebates on energy expenses of the poor be designed to alleviate the burden on a particular social group? What were the findings of the Ford Foundation's Energy Project as to which group bears high social costs? (Refer to chapter 4, 4-18.) How can the policy makers seek public support for their policies?

2) How would a better understanding of the social costs involved in various energy options aid in formulating policies? Since the government often ends up paying social costs of poor energy planning, it would benefit from requiring companies and utilities to shoulder more of the social costs. How might this slow economic growth? This is a problem, for example, for developing countries that seek to regulate the operations of multinational corporations, but risk losing the MNC's business if regulations are too stiff.

3) For further research. How was the revolution in Iran related to discontent with the policies of the Shah's government in regards to distribution and use of oil revenues? What are the oil production and other economic policies of the new government? What was the global impact of Iran's political instability--both on fellow producers and on oil consumers? Why didn't the Shah's concern for national security, as evidenced by large purchases of military equipment, insure him against political overthrow?

6-7. Country surveys

To study a nation's energy policies, one should first examine its physical geography and climate to learn what resources are available. Mountains and moderate rainfall, for example, mean rushing streams for hydroelectric power. A nation's social and economic indicators, such as population size and distribution, major industries and economic growth will provide an idea of the size and nature of energy demand. The final element in a nation's energy policies are its priorities--whether, for example, energy independence or military security is more important than economic growth or environmental quality.

We will briefly outline here the energy situation and policies of five countries--Sweden, China, Brazil, Saudi Arabia and Zambia--and provide references for further research. You may be asked to prepare a summary of one nation's energy policies, or to compare aspects of different policies. The countries have been chosen simply to represent a cross-section of regions and types--you may choose to study other examples, depending on the availability of information.

A. Sweden: Population: 8.2 million
GNP per capita: $9,250
Energy production: 8.73 million metric tons of coal equivalent
Energy consumption: 49.71 MT
Energy consumption per capita: 6,046 kilograms of coal equivalent

[Note: statistics for the countries are from the 1977 U.N. Statistical Yearbook and the 1977 World Bank Atlas.]

Sweden's geography is divisible into two major areas: the mountainous and hilly northwest, with a small population employed in timber and iron ore industries and hydropower production; and the plains and hills of the southwest with advanced agriculture and manufacture of high quality finished products, such as cars, ball bearings and electrical equipment. Given its topography and high precipitation, Sweden's prime energy resource is hydropower, which provides about 70-75% of electricity production, or 12-15% of total energy supply. Wood-burning stations also produce energy in the forested areas. All of Sweden's coal and oil for power-generating and steel production must be imported, most of the latter from the Middle East and Africa. Because it has uranium ore deposits, Sweden has built several nuclear power plants, but public opposition in the recent years has led to a halt in the expansion of the program. Increased exploitation of hydropower locations has met with environmentalists' resistance.

While Sweden's GNP per capita is comparable to that of the U.S., per capita energy consumption is only about 60% of the U.S. figure. Because Sweden imports nearly 70% of its energy, prices have been kept high, and demand is lower. Nineteen percent of the total residential heat needs in Sweden, for example,are supplied by district heating from a central plant, and industries have found ways to recycle the heat needed to process materials. Increased population density in urban areas has meant less energy spent in private transportation and single-family dwellings.

Energy policy in Sweden focuses on reducing dependency on imported oil, without yet increasing hydroelectric or nuclear power generation. This means reducing demand further, increasing the search for Swedish oil and exploring energy alternatives, particularly solar and coal power and safer nuclear technology. A renewable energy system, utilizing wood, solar heat, hydropower and methanol production from organic materials is feasible, but would require substantial political commitments, as well as commitments of land area and capital resources.

Sweden is a post-industrial society, like the U.S., characterized by a relatively high level of energy consumption, a large percentage of the work force in service industries (50%) and a small percentage in efficient agricultural production (7%). Sweden, like Japan, relies on large energy imports and pays for them with the

export of high-quality, high-technology products that require skilled and expensive labor. Sweden has a comprehensive and advanced social security system, with experience in forward planning. However, there is evidence of popular restlessness with the "bland," relatively uniform and comfortable standard of living, and the high taxes and government regulation necessary to support it.

Questions for discussion:

1) How do Sweden's geography and climate affect energy supplies and demand? What are Sweden's major natural resources and industries? What kinds of energy do these require?
2) How must the environmental effects of energy use be balanced with the need to preserve the natural resources important to Sweden's economy? Why is Sweden concerned about the effects of acidic rains from the air pollution of Germany's coal-burning industries on its forests?
3) How does dependence on oil pose risks to Sweden's economic and political security? How might access to North Sea oil decrease the risk of Sweden's oil supplies being cut off?
4) What are Sweden's options for the future, as far as conservation, increased fossil fuel production or energy alternatives? What might be the social costs involved?
5) For further research. How is Sweden's situation like that of Japan? How does it differ?

B. China: Population: 849.02 million
GNP per capita: $410
Energy production: 614.78 MT
Energy consumption: 590.06 MT
Energy consumption per capita: 706 kg

The geography of western China is characterized by mountains and high, arid, thinly populated plateaus, while eastern China's low rolling hills are well watered by three major river systems and are densely settled. Because of its large size, China's climate varies from region to region--ranging from tropical, monsoonal regions in the south to the cold, continental regions of the northeast.

Eighty percent of the Chinese labor force is employed in agriculture, and China's arable land is fully exploited and very densely populated. Because the land has been extensively cultivated for a long time, the fertility of the soils has declined in many areas. Forests cover only about 10% of the land, and the felling of trees has caused significant soil erosion, particularly in the northern mountainous region.

China's energy reserves are not very fully known, because of a lack of exploration technology and a reluctance to divulge the official figures. It is known, however, that China is the world's third largest coal producer. Much of this coal is produced from

small mines in the north, and the Chinese claim to have found large deposits in the south.

The amount of Chinese oil reserves is not yet clear, but oil has been found both inland and off-shore. China has been able to export oil, because domestic oil demand is still very low. China also has a high potential for hydroelectric generation and utilizes small-scale generators on local dams, but many of the potential sites are located in the mountainous areas, far from the areas where demand is greatest.

The Chinese have emphasized and greatly expanded the use of biogas converters in rural villages to produce methane gas for fuel and high quality fertilizer from human and animal wastes and from stubble and crop wastes left after the harvests.

Under Mao Zedong's leadership, the Chinese placed high priority on self-reliance, collectivization and agricultural development. Since Mao's death the emphasis has begun to shift toward industrialization and individual incentive. China's economic development is hampered, however, by the lack of technology, capital and an adequate infrastructure of railroads, roads, electric lines, pipelines, communication systems and economic institutions. In an effort to obtain fuels for industrialization or for export to obtain foreign capital, the Chinese have adopted an energy policy of increased fossil fuel exploitation and have attempted to locate industries near energy-generating sites. Nuclear energy may be an option, as China already has nuclear weapons, but it would require large capital expenditures and some foreign technology. Conservation could be practiced by incorporating energy-saving techniques in new industries and construction, but at the individual level there is little room for further cutbacks.

Questions for discussion:

1) How do the geography and climate of China's regions affect energy supplies and demand? How do the limited forests and intensely cultivated land affect the choice of renewable energy resources?

2) What is the primary occupation of China's work force? What kinds of energy are required? China has tried to encourage decentralized industry and emphasize rural over urban development. Which energy sources are more applicable to a decentralized, rural emphasis? Which are more effective for centralized, energy-intensive sites?

3) Why has China used little oil in the past? How might a program of increased industrialization affect oil demand? What are the possible effects of Chinese oil production? For example, how might increased supplies of Chinese oil affect Japan's plans to aid the U.S.S.R. in developing Siberian oil resources?

4) Why is the existence of an infrastructure of railroads, pipelines, high-tension wires and roads necessary for

increased industrialization? How will the lack of these determine what oil, coal or hydroelectric reserves can be used, and which cannot?
5) What are China's options for future conservation, fossil fuel production or energy alternatives? How are policy decisions made in China? Why is obtaining advanced technology a critical need? How will increased use of foreign capital and technology affect China's political goal of self-reliance? How might China's choices affect world politics?
6) Contrast the situations in China and Sweden. How do they differ in size, share of labor force in agriculture, types of industry, energy resources and future prospects?

C. Brazil: Population: 113.21 million
GNP per capita: $1,390
Energy production: 26.47 MT
Energy consumption: 79.84 MT
Energy consumption per capita: 731 kg

Brazil's geography can be divided into three major areas: the Amazon basin in the north, with its low-lying plains and tropical rain forests; the plateaus and mountains of the center and east, the northeastern parts of which are prone to severe drought; and the region to the south and southeast, characterized by steep coastal escarpments, inland hills and valleys, and a varied climate.

Over half of Brazil's labor force is still employed in agriculture, and most of Brazil's exports are agricultural products. The central eastern state of Minas Gerais has rich and varied mineral resources. Brazil's population is largely concentrated in the coastal areas, particularly in the south and southeast, while the northern interior remains relatively undeveloped. While Brazil has achieved substantial economic growth in recent years, the much slower progress in social development has increased the gap between the richer and poorer sections of society. Many have not shared in the country's new wealth, but are faced with inadequate living conditions.

Although exploration efforts have not been completed, Brazil's oil resources are limited. Oil shale deposits exist in the south, but the extraction costs are still prohibitively high. Southern Brazil also contains Brazil's only large coal deposits, which are unfortunately of low quality and high sulfur content. In the late 1960's, Brazil began a strenuous program of industrialization, which now relies on imports for 80% of its oil needs. With the steep rise in oil prices, coupled with the reduced demand for exports as a result of the worldwide economic slump, Brazil was hard-pressed to find alternatives to imported oil.

Brazil's national oil company has intensified the search for domestic oil resources, and has invited the participation of foreign oil companies. In 1975, Brazil made a controversial agreement

with West Germany for the technology, design and construction of several nuclear generating plants. Hydroelectric power has expanded, but has not been fully exploited, because some sites are inaccessible as yet to the industries which could use the electricity. To cut back on gasoline demand, the government allowed already high prices to rise considerably.

Brazil has also invested considerable time and money in renewable resources, specifically the production of fuel alcohol (poisonous to drink) from crop residues, such as sugar cane bagasse. The alcohol is mixed with gasoline to produce gasohol, a mixture suitable for use in existing automobile engines. Engines can also be adapted to run on an alcohol fuel.

Questions for discussion:

1) How would the climate and geography in Brazil's different regions affect energy supply and demand?
2) What is the primary occupation of Brazil's work force? The major industries are steel and aluminum production, cotton textiles, petrochemicals and heavy machinery. What are the energy requirements for these industries?
3) How does the concentration of population in coastal areas affect energy demand and options? Why would development of Brazil's interior require building an infrastructure of transportation, communications and energy networks?
4) Why is the ecological balance a particularly important consideration in the arid plateaus and in the rain forests?
5) Brazil's major exports, which include coffee, soybeans, sugar and cocoa, are agricultural commodities subject to fluctuations in the price they can bring on the world market. How does this help explain the economic reasons for reducing the amount of imported oil? for wanting to expand industrialization?
6) What are Brazil's options for the future? How are policy decisions made in Brazil? What might be the social, political and economic costs of emphasizing the improvement of living conditions among the poorer groups? of emphasizing the creation of new industries?
7) How is Brazil's situation like or unlike Sweden? China?

D. Saudi Arabia: Population: 9.25 million
GNP per capita: $4,980
Energy production: 643.99 MT
Energy consumption: 17.56 MT
Energy consumption per capita: 1901 kg

Except for the south-western region of the country, where rainfall is sufficient for agriculture, most of Saudi Arabia is rock or sand deserts. Although there are no continually flowing rivers, enough underground water exists in some places to supply wells for irrigation. More important than agriculture is the raising of camels and other animals by nomadic groups.

Ninety-nine percent of Saudi Arabia's exports are oil or oil products, and the country's chief trading partner is the U.S. Most oil production is in the eastern region, on the Persian Gulf. Saudi Arabia's energy policies have focused on obtaining maximum benefits from its vast oil reserves.

In order to avoid exclusive dependence on this limited resource, the Saudis have used oil earnings to invest in diverse industries, including the refining and processing of their own crude oil. Because Saudi Arabia's population is small, scattered and largely untrained in modern technical skills, foreign technology and workers have had to be imported on a large scale, and expensive programs of education and social improvement as well as economic development have been begun.

Saudi Arabia has invested a substantial share of its oil revenues in the industrialized West, and thus depends on the West's economic stability for the security of its investments. The oil pricing policies of Saudi Arabia, as leading producer of the OPEC nations, are designed to balance maximum profits for oil with minimum disruption of the global economic system.

Saudi Arabia is interested in the development of alternative energy resources, and solar energy in particular. The dry, sunny climate and large uncultivated land areas would be suitable for all forms of solar energy. Solar desalination of sea water is naturally, of considerable interest. Although oil supplies for domestic use are certainly abundant, the oil can instead be exported to earn foreign capital needed to finance development projects. And if oil prices continue to rise, oil left in the ground as an investment for the future will earn even higher prices.

Questions for discussion:

1) How do Saudi Arabia's climate and geography affect energy demand and resources?
2) What was the economy like before the large-scale export of oil? How have the traditional economy and the geography of Saudi Arabia made necessary large, initial investments in building an infrastructure, before industrialization can proceed?
3) Why are the Saudis interested in diversifying their economy? What petroleum derivative industries could Saudi Arabia develop? Most of these industries require advanced technology which must be imported. How does this increase the need for foreign money earned through oil sales?
4) How would the discovery of new, large oil reserves, as in Mexico, affect Saudi Arabia's position? How long a delay is there between discovery of oil and its production for sale on the world market?
5) How is Saudi Arabia involved in Middle East politics? Why might the U.S. be particularly interested in preventing the outbreak of an Arab-Israeli war?

6) How are energy decisions made in the Saudi government? What is the relationship of the government to the major international oil companies that buy Saudi oil?
7) How does the situation in Saudi Arabia compare with that of other developing countries we've surveyed? Does a large supply of oil guarantee future security?

E. Zambia: Population 5.21 million
GNP per capita: $450
Energy production: 1.31 MT
Energy consumption: 2.81 MT
Energy consumption per capita: 5.48 kg

Zambia is a landlocked country which lies on a high plateau rising to mountains in the northeast and cut by steep river valleys which hinder transportation. In the south, the Zambezi River plunges over Victoria Falls and is dammed up further along its course to form Africa's largest man-made lake, Lake Kariba. Zambia's mild climate and light, seasonal rainfall support the growth of grassy, tree-studded plains. Almost 60% of the population is employed in agriculture, mostly on a subsistence level, but also in the production of crops such as tobacco and maize for export.

Zambia is the world's largest copper producer, and its copper resources are the source of about 96% of Zambia's export earnings. The mining industry consumes about three-fourths of all the energy produced in Zambia. Over 75% of Zambia's energy comes from hydroelectric plants, such as the Kariba Dam on the Zambezi River and a generating station at Victoria Falls. Zambia also has coal deposits, but must import all its oil.

Because of its location, Zambia depends heavily on its neighbors to provide outlets for trade and transportation routes for oil imports. Until recently, much of Zambia's trade traveled on the joint railroad with Rhodesia, a country under a white minority government. As tensions grew, Rhodesia disputed Zambia's access, and an international embargo on oil to Rhodesia, as a protest over the country's government, left Zambia without oil as well. In 1968, a 1,058 mile pipeline was completed, to bring oil across Tanzania, and in 1974, a railroad was built between the two countries with aid from China.

Outside of copper mining, Zambia's economy is still weak. There is some textile manufacturing and food processing, mostly along the rail line between Lusaka and the copper belt, but few other industries. In an effort to avoid uncontrolled growth of the urban areas, the Zambian government has been encouraging rural agricultural development. Hydropower has not yet been fully exploited, but Zambia plans to expand generation so that it can export electricity.

Zambia is also expanding the industrial sector of its economy,

but the future is dependent on Zambia's relations with its neighbors, particularly Rhodesia, now called Zimbabwe Rhodesia, which controls much of the power from the Kariba Dam; and South Africa, which has provided technology, financing and machinery for Zambia's copper mines. Self-reliance is not a possible goal for landlocked Zambia, but it has in its copper deposits a source of revenues to finance further development.

Questions for discussion:

1) How do Zambia's climate and geography affect energy supplies and demand? What problems are caused by its landlocked position? What is Zambia's major industry? How does this affect energy demand?
2) From what source does Zambia often obtain most of its energy? Why does it still need oil? How does the import of oil pose problems?
3) What are Zambia's options for future energy policies? Who will make these decisions? How does Zambia depend on peaceful interdependence to guarantee its oil supplies?
4) How have Saudi Arabia and Zambia each dealt with their nation's dependence on the export of a single nonrenewable resource? How alike are Sweden and Zambia in their combination of hydroelectric power and ore mines?

6-8. U.S. energy situation

We have very briefly surveyed the energy situations in five countries, to learn how the differences in the geography, economy, government, and priorities of these countries share differing energy policies. Let us now turn to the U.S. energy plan, to examine the interplay of these factors and focus on the first of them in this section.

a. What is the energy situation in the U.S.?
b. What does the plan call for?
c. Who makes energy choices?
d. What else should be done?

The energy situation in the U.S. is one of rising demand and diverse and sizable energy supplies, not all of them easily exploitable. (See chapter 1, figure 8, for a graph of U.S. energy use.) Until 1964, the U.S. was the world's largest producer of oil. As the oil has become more difficult and expensive to extract and as demand has grown, the U.S. has turned increasingly to imported oil. Coal and uranium deposits are extensive, but environmental, economic and human safety concerns have slowed their use. The size and geographic diversity of the United States offer potential for a variety of renewable energy resources, but these will require investments and research before they can contribute significantly to the nation's energy supply. Major hydroelectric sites have nearly all been put to use, although there still exist smaller, local sites with potential for hydro-plants. The size of the U.S. also means a variety of energy requirements from Maine to Arizona.

The current energy problems in the U.S. have arisen because our modern economy and lifestyle are based on available oil, which was kept inexpensive by government oil-pricing policies. As U.S. oil supplies dwindle, the U.S. must buy oil on the world market, where demand from other oil-consuming countries is increasing. With one-half of its oil requirements filled by imports, the U.S. must depend on other countries for a secure, continued supply of oil. Disruption or reduction of the oil production of any major oil supplier can affect importers worldwide, including the U.S. Since a large share of the world's oil exports come from the politically troubled Middle East, the potential for disruption is great, as was shown in Iran when oil production was reduced following the departure of the Shah.

Activities:

1) Research project. Prepare a list of the major energy sources in the U.S., and the estimated lifetimes of these reserves. Where are these resources located? Which are most abundant? Prepare also a list of U.S. energy imports. What fuels are imported? From what countries are they imported? Focus in particular on the energy resources of and trade with our neighbors, Mexico and Canada. How will their situations and policies affect the U.S. energy future?

2) Research project. Study the energy resources and imports of your own state or region. How are states interdependently connected? What are the major sources of power for your state? From what countries is the energy imported? (Ask your local utility company for this information.) Does your state export energy to other states or countries? How do geography, climate, agriculture, industry and population influence the types and amounts of energy needed? (What are the likely future needs? What are the state policies for the future?) Which of the countries surveyed in section 6-7 does your state most resemble in resources and energy policies?

6-9. U.S. energy plan

The U.S. energy plan, as prepared by the Carter Administration and revised by Congress, lists as its two top priorities:

1) to reduce dependence on foreign oil and vulnerability to supply interruptions

2) to make as smooth a transition as possible from fossil fuels to renewable sources of energy.

The plan also lists as priorities economic growth and stability, environmental protection, fair division of political and social costs, increased production of fossil fuels and reduction of energy demand through conservation.

It calls for, among other things, high taxes on gas-guzzling cars and rebates on more fuel-efficient cars, encouragement of public transportation by easing taxes on buses and jet fuel, the restructuring of utility rates to discourage wasteful uses, loans for insulation and solar energy installation, and funds for research on

alternative energy sources.

Activity and questions for discussion:

1) Read a copy of The National Energy Plan from the Department of Energy, (see Bibliography for the address) and look over the energy policy measures listed in the summary. How are these designed to help save or produce energy? Which fuels receive more attention: oil, gas, coal, solar, wood? What mechanisms, such as taxes, rebates, government funding or legislation, are used to implement the policy measures? Why is education of the public important to the success of this policy?

2) What might be some of the environmental, social and economic effects of the major provisions of the energy bill? What will be its possible effects on oil-exporting countries? oil importers? less developed countries?

3) For further research. What energy policies have been introduced, approved or rejected since the adoption of the national energy plan? How have these supported or altered the original plan?

4) How does the U.S. energy plan compare with energy policies of the five countries we surveyed?

6-10. Policy makers

Energy decisions are made at many different levels, from the federal government to businesses to the individual consumer. Some have widespread and long-range effects, while others may be localized and immediate, but all have some impact on the overall energy situation.

Questions for discussion:

1) How are energy decisions made at the level of federal government? Who is responsible for the formulation of an energy plan? for revising the plan and making it law? for enforcing the provisions of the plan? How influential are decisions at the federal level? The Department of Energy was formed in 1977. What are its responsibilities and powers?

2) How are decisions made at the state level? Does your state have an energy agency? What responsibilities does it have? What are the state laws governing energy use? How are states involved in enforcing federal laws, such as the 55 m.p.h. speed limit?

3) How are decisions made at the local level? What kinds of energy decisions are made at this level? (You may wish to talk to your town councilmen or other local officials.)

4) How does the public become involved in and influence energy policy at the federal, state and local levels? Do you think all sectors of the economy and society are sufficiently represented in energy decisions? What are "lobbyists"? What special interests are represented by lobbies related to the energy issue? What influence do such groups have on federal, state and local legislators?

5) How do decisions of private businesses and companies affect energy policies? How are these decisions made? How can public influence on decisions be increased by, for example, buying or not buying certain products? How else does the public exert influence on business?
6) What are the effects of energy decisions by families and individuals or by institutions such as schools and hospitals? How are these influenced by the policies made at other levels?
7) How do the various levels of decision on energy form a complex and interdependent system? How swiftly can decisions be made at the various levels, to meet new or changing energy situations? How far ahead can long-range plans be made? How do short terms of office and re-election needs often make long-range planning difficult or unpopular for federal and state political representatives?

6-11. Policy project

To put into a practical form the facts, concepts and opinions about energy that you've discovered in this course, your final major project will be the preparation of a set of recommendations for energy policies at all levels in the United States. (This could be done for another country instead of the U.S., if there is sufficient information on and understanding of the resources, politics, priorities and institutions of that country.) You may be asked to write a recommendation paper on your own, or in a team or committee of fellow students, or as a class congress with each individual or committee assigned a segment to work on.

The final recommendation paper should include:

1. A brief statement of the present energy situation and likely future trends, supported with data from a reliable source
2. The major priorities of your energy plan
3. Your recommendations for federal, state and local governments, and for businesses, families and individuals in the appropriate areas of a) conservation, b) increased production of fossil fuels, and c) alternative energy sources
4. An impact statement summarizing the expected results of your plan and its likely effects on the nation's economy, environment and society.

If the recommendation paper is compiled in a class congress, it may be helpful to have an executive committee or chairman to review the proposals and make sure they are consistent before combining them in the final paper. Inconsistencies may require discussion and resolution in class.

Questions for discussion:

1) How do your recommendations compare with the recommendations in the national plan? What are your areas of agreement and disagreement?

2) How might your plan affect other nations?
3) Project. Public support is important to the success of any energy policy. Design posters, bumper stickers or "commercials" that would encourage public understanding and support of your energy plan.

Activities:

1) If your teacher or professor approves, you may wish to send a copy or summary of your recommendations to your federal, state or local representatives or officials, particularly to those who may have worked with you previously in this course. What are their reactions to or opinions on your report?
2) The President can appeal directly to the public for support on issues of importance in a televised or radio-broadcast speech. Write a Presidential speech explaining the major provisions of your energy plan and urging support. (If your school has videotape equipment or tape-recorders, you may want to record this speech.
3) An energy plan for the United States will have effects on other countries as well. How would the U.S. Ambassador to the U.N. explain and justify the energy plan you've devised to a U.N. assembly of the world's nations? You may want to write and present this speech. How might the U.S. Ambassadors in Europe and Japan describe and explain the plan to their host countries? Ambassadors in the five nations we surveyed in 6-7?

6-12. International cooperation

Energy is a global issue because every nation uses energy and needs secure supplies for the future. The world economy runs on energy, as does world agriculture, and military security depends on adequate energy supplies. Worldwide demand for energy is increasing, while supplies are unevenly divided among the world's nations. As with other global issues, the world's energy interdependence means that no single nation can remain unaffected by the energy policies and decisions of other nations.

On an issue as vital and global as energy, international cooperation is necessary. As yet, most of the international organizations are composed either of energy exporters or importers, such as the International Energy Agency (IEA), which was formed after the 1973-4 oil embargo to unite energy-importers in an oil-sharing plan, in case of future embargoes.

Some existing international institutions, like the World Bank, have begun to devote more attention and funding to energy issues. For example, developing countries have received loans from the World Bank for the development of domestic fossil fuel supplies, and for the development of renewable energy resources. The U.N. and several other established international institutions can also provide a forum for discussions between importing and exporting groups.

Questions for discussion:

1) How might international disputes arise over energy sources? For example, over a river flowing through two countries; over oil deposits in the oceans; over the burning of sulfurous coal; over the use of nuclear reactors? What are the existing international organizations that could arbitrate such disputes?

2) Recall the energy policies of the nations we studied including the U.S. Are there areas for international cooperation?

3) How can the adoption of a comprehensive, well-balanced energy policy by the United States make international cooperation easier? How else can the U.S. cooperate on energy issues, such as nuclear technology? How could international cooperation affect the energy plan you recommended for the U.S.?

4) How does the relationship between energy and national security make cooperation with an international organization more difficult for individual nations? Why is international cooperation necessary? How can wars disrupt energy supply routes and increase demand?

Chapter 6. References and suggestions for further reading.

6-1. Setting priorities through 6-6. Social Effects

Committee for Economic Development. International Economic Consequences of High-Prices Energy. Information on international economic effects of oil prices.

Energy Policy Project of the Ford Foundation. A Time to Choose--America's Energy Future. Reference for section 6-6, Social effects.

Helmut J. Frank and John J. Schanz, Jr. The Economics of the Energy Problem. Discussion of economic factors in energy policy planning.

Anton B. Schmalz, ed. Energy: Today's Choices, Tomorrow's Opportunities, Essential Dimensions in Thinking for Energy Policy. Short articles on aspects of policy planning.

World Bank. Press Release. Information about loans to developing countries for energy projects, as noted in section 6-2. Budgeting resources.

6-7. Country surveys

African-American Institute. Suggestions for Studying Libya and Nigeria. Packet of materials on the policies of these two oil-exporting countries. Basis for a country survey.

American Association for the Advancement of Science. Science. The April 14, 1978 issue contains articles on energy policy, including "Brazil: Energy Options and Current Outlook."

Atlas: World Press Review. Source of viewpoints from other countries.

Center for Economic and Social Information. Development Forum. Source of Third World viewpoints.

Robert D. Crane. "Planning, Islamic Style." Fortune article on the priorities and goals of Saudi energy policy, relating energy and development concerns. Good reading for the country survey of Saudi Arabia.

Paul Ward English. World Regional Geography. Text with maps of energy resources for each world region.

Global Development Studies Institute. Focus on Brazil: A Case Study of Development. Good background information for a survey of Brazil, includes discussion of development concerns.

James W. Howe. "Energy and Developing Countries." Summary of the problem.

Lawrence W. Latour. Inquiry Experiences in Geography. Background text for geography skills.

Louis J. Mihalyi. "Legacies of Colonialism: Zambia." Focus issue to accompany Zambia survey.

The Organisation for Economic Co-operation and Development. The OECD Observer. Information on European countries' energy resources and policies.

Alan Riding. "Mexico Grapples with Its Oil Bonanza." New York Times article on energy and economic policy planning in a developing country.

Swedish Information Service. Human Environment in Sweden. The newsletter frequently contains detailed information on aspects of Sweden's energy situation and policies. Reference source for country survey of Sweden.

United Nations. U.N. Statistical Yearbook. Extensive compilation of data on the world's nations, includes energy-related data. Sourcebook for surveys.

U.S. Department of State. Background Notes. Factual summaries of 160 countries; color maps also available. Basic materials for country surveys.

World Bank. World Atlas of the Child. 1979 atlas of data on the world's nations. Reference and world map for surveys.

6-8. U.S. energy situation

Current History. "America's Energy Resources: An Overview." May/June 1978 issue.

New Jersey Department of Energy. For information on state resources and policies.

U.S. Department of Energy. Energy in Focus--Basic Data. Information on the U.S. energy situation.

6-9. U.S. energy plan

Executive Office of the President. The National Energy Plan. The 1979 plan summarized and explained.

6-10. Policy-makers

National Science Teachers Association. How a Bill Becomes a Law to Conserve Energy. Curriculum on the legislative and political systems of the U.S.

James Martin. "The United States and the Energy Crisis: A Study in Economic Decision-Making." Discussion of the 1973-4 energy crisis and resultant policies.

6-11. Policy project

Gerald O. Barney, ed. The Unfinished Agenda: The Citizen's Policy Guide to Environmental Issues. Policy recommendations regarding energy.

Committee for Economic Development. Achieving Energy Independence. A model format for policy recommendations.

Foreign Policy Association. Great Decisions '78. Guide to discussion of energy policy issues.

Craig S. Karpel. "Ten Ways to Break OPEC." Harper's article with policy recommendations for the U.S.

John Knox Press. Baldicer. Simulation game for resource planning; the resource here is food, but the lessons and experience would apply equally to energy policy planning.

John C. Sawhill, Keichi Oshima and Hanns W. Maull. Energy: Managing the Transition. Policy recommendations for the U.S., Europe, Japan and Canada.

Robert Stobaugh and Daniel Yergin. Energy Future. Project report with good recommendations for national energy policies.

Joseph A. Yager, Eleanor E. Steinberg et al. Energy and U.S. Foreign Policy. Analysis of international aspects of energy policy.

6-12. International cooperation

International Energy Agency. For information on their work to coordinate energy policies of oil importers.

John W. Sewell and the staff of the Overseas Development Council. The United States and World Development--Agenda 1977. Energy as a global issue requiring international cooperation.

United Nations Association of the United States of America. Science and Technology in an Era of Interdependence. Overview of energy as a global issue, and suggestions for international action.

APPENDIX I

Answers to Energy Survey, Section 1-1, p. 1 :

1-4. These are opinion questions; there are no right or wrong answers, and your answers may change during this course.

5. (b) The U.S. currently imports about 1/2 of the oil it uses each year.

6. (c) Japan and the European countries import more than 90% of the oil they use each year, with the exception of Norway, which exports a moderate amount of North Sea oil.

7. (b) Jordan exports no oil.

8. (e) Morocco is not an OPEC member.

9. (c) The U.S. consumes over 1/3 of the world's energy produced each year.

10. (b) The U.S. contains 6% of the world's population.

11. (b) 15 man-days of labor (or 32 kilowatts).

12. (c) 94% of the energy in crude oil is lost between crude oil and your moving car.

13. (d) wood

14. (c) In less than 500 years of consumption, man will have essentially depleted the supplies of coal, oil and gas that nature started forming 500,000,000 years ago.

15. (b) Wood was the most used fuel 200 years ago.
(c) Coal had replaced wood as the major fuel 100 years ago.

16. (c) Oil provides the largest part of current energy consumption in the U.S.

17. (a) More electricity is produced in coal-burning power plants than in any other type of plant.

18. (b) In the past 100 years, demand for energy in the U.S. has doubled, on the average, every 20-25 years.

19. (c) The use of the pesticide, DDT has caused bald eagles to lay eggs with weak, fragile shells. Deforestation is caused by

the overgathering of wood needed for cooking and heating. Acidic rains result from releasing smoke from coal burning into higher levels of the atmosphere. Carbon dioxide is produced by the burning of fossil fuels and of wood and organic materials, as well.

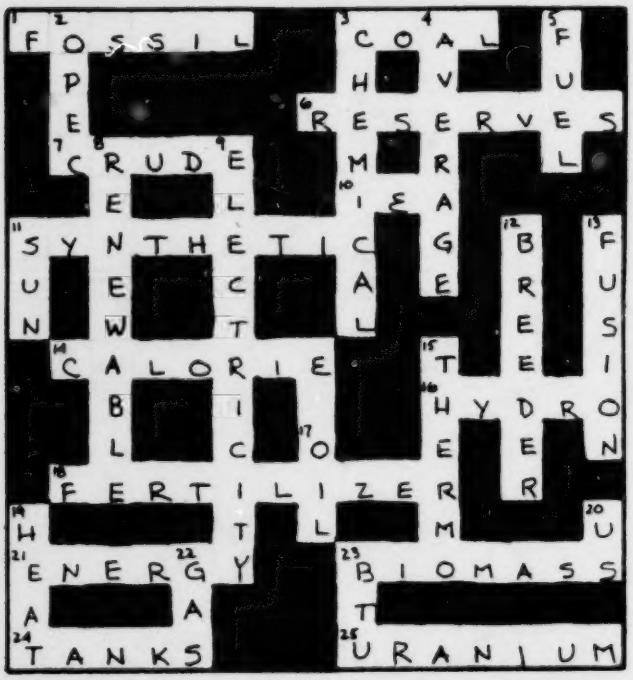
20.(c) The price of oil rose from about $2.80 in 1973 to about $11.50 a barrel in 1974.

21.(c) The processing of aluminum ore requires a great deal of energy. Recycling can save a lot of energy. The energy wasted in the total number of throwaway containers in the U.S. is equal to the output of 10 large nuclear power plants.

22.( ) Petroleum can be synthesized or extracted from coal, oil shale and tar sands. As of yet these methods are more expensive than pumping petroleum from wells.

23. This is an opinion question, open to differing answers.

Solution to Energy Crossword Puzzle, Section 5-4, p. 78:



APPENDIX II

Section 1-3. Energy Crisis? Sampling of expert opinion.

Reading #1: from "An Oil Crisis: True or False." Time, April 23, 1979; Volume 113, Number 17, p. 60.

Time interviewed at length five leading independent oil experts. They are: Morris Adelman, 62, professor of economics at Massachusetts Institute of Technology; Walter Levy, 68, the dean of petroleum consultants and advisor to governments and oil companies; John Lichtblau, 57, head of the private Petroleum Industry Research Foundation; Arnold Safer, 42, an economist of Irving Trust Co.; John Sawhill, 42, president of New York University and former Federal Energy Administrator. Excerpts from the interviews:

Is there a crisis?

Levy: The Iranian revolution triggered a real crisis. The protests against corruption and excessive development will encourage other OPEC countries to slow oil production. There is nothing in sight that would lead to very substantial increases in oil supplies in the immediate or even medium-term future.

Adelman: There is no genuine supply crisis. There was an accident, Iran. We are traveling a bumpy road, and will continue to do so as long as OPEC is in charge. There is nothing we can do to make the cartel produce more. We have handed control of world oil over to a small, noncompetitive and irresponsible group.

Sawhill: I prefer to call it not a crisis, but a problem, arising from our growing dependence for oil on a politically unstable part of the world. We have failed to curtail imports, and in the short term we are completely at the mercy of the Middle East oil suppliers.

Safer: There are some crude shortages, but there is no crisis of physical supply. In the longer run, there is no shortage in terms of proven reserves or potentially discoverable oil.

Lichtblau: We are not going to run out of oil, but we may run out of suppliers who are willing to give us more, even if it is available. Oil can be denied either for political reasons or because a country simply has no economic interest in increasing production. That is the danger.

Reading #2: from "The Phony Oil Crisis," Peter Deutsch. The Nation, Volume 228, Number 15; April 21, 1979.

If the oil shortage is "real" it is because oil companies are building up inventories. The companies do not intend to reduce the inventories at the present price levels; it makes perfect economic sense for them to act in exactly the way they have been acting.

Oil companies have often used political crises for their economic benefit. As the Gore study* points out, "After the emergency has subsided, the forces that have pushed prices upward never allow prices to recede to their previous levels. Thus, the world price structure has assumed after each "emergency" a higher permanent plateau.

*Congressional Research Service Study released March 1, 1979 by Representative Gore.

Reading #3: from "The ABC's of the Energy Crunch." U.S. News and World Report, Volume LXXXVI, Number 11, March 19, 1979, pp. 66-70.

[An overview of the current situation and the short and long-term prospects for the future, focusing on actions taken by the government and the oil companies. The article is based on interviews with oil company experts.]

"Is America really in or headed for a major fuel crisis?"

Most experts agree with Carter. The situation is serious but not critical. They believe that the major short-term impact will come from higher prices, not serious shortages. Over the longer run, the United States faces a period of uneasy balance between supply and demand--making it vulnerable to unexpected events such as the shut-off of Iranian oil.

Petroleum companies say that they do not have sufficient refining capacity in this country to meet the growing demand for fuel, particularly unleaded gasoline. The problem is blamed on federal gasoline price controls, which, the industry claims, makes it unprofitable to expand refining capacity...

Will gasoline reach $1.00 a gallon soon? Not this summer. Gas prices...probably will rise to about 80 cents by the year's end with prices possibly hitting $1.00 a gallon by late 1980.

Reading #4: from "Herman Kahn Revisited," Anthony J. Parisi. The New York Times. Sunday, February 26, 1978, section 3, p. 1.

"First of all," he starts, "you have to keep in mind that there's no shortage of energy yet. Everybody complains that the average American doesn't appreciate the fact that we have an energy

crisis. Well I think the man in the street has this thing pegged exactly right. He has to pay more for his gasoline, but he gets all he wants, and he knows it. Four years have passed, and his government hasn't done one thing about it. So why should he? We haven't got an energy crisis--we've got an energy problem."...

"Not only that, but there's no shortage of solutions. Can I think of a single thing that won't work? Yes --what we're doing. No way you could have written a scenario of the last four years that I would have believed. It's incredible that we're still subsidizing energy."...

Mr. Kahn's hope for avoiding higher oil prices in the near term rests mainly with a trend he sees toward a worldwide slowdown in economic growth. He believes that an overtaxed world produces people who decide that the world is becoming overtaxed. So, consciously or unconsciously, they slow things down....

He thinks economic growth is already tapering. That means slower energy growth. Conservation, spurred by higher prices, is taking hold, too, he adds. That means still lower energy growth....

With that, he begins to explain why the United States should, despite his optimistic outlook for energy, immediately start spending billions on building--of all things--shale oil plants...

Thus Mr. Kahn's new idea: draw up plans for a $200 billion synfuels industry by the 1990's. That, he says, would mean 200 plants capable of producing the equivalent of 10 million barrels of oil each day. Have the Government, working with private industry, start implementing the plan at once, though at a relatively modest pace at first. Gear the schedule to a long list of "contingencies and hedges," permitting midcourse corrections as events unfold. Accelerate development if things take a turn for the bad; decelerate if they start looking good. And if any of the many preferable alternatives to the synfuels plan fully pans out, abort the plan altogether.

Reading #5: from Workshop on Alternative Energy Strategies. Report of the Workshop on Alternative Energy Strategies. Energy: Global Prospects 1985-2000. New York: McGraw-Hill Book Company, 1977, pp. 3-4.

Our major conclusions are as follows:

The supply of oil will fail to meet increasing demand before the year 2000, most probably between 1985 and 1995, even if energy prices rise 50% above current levels in real terms. Additional constraints on oil production will hasten this shortage, thereby reducing the time available for action on alternatives....

Although the resource base of other fossil fuels such as oil

sands, heavy oil, and oil shale is very large, they are likely to supply only small amounts of energy before the year 2000....

Other than hydroelectric power, renewable resources of energy--e.g. solar, wind-power, wave-power--are unlikely to contribute significant quantities of additional energy during this century at the global level, although they could be of importance in particular areas. They are likely to become increasingly important in the 21st century.

Reading #6: from "Energy Analysis," American Gas Association. January 19, 1979, p. 7.

The broadly held view that oil and natural gas resources are approaching depletion is not supported by the statistics which show that only 20.1% of the world's oil and 9.7% of the natural gas had been consumed by year-end 1978.

The perception of a rapidly approaching world resource depletion is proved fallacious by current statistics. With only 20.1% of the world's recoverable oil consumed by year-end 1978, almost four times what had been consumed still remains in the ground. The natural gas situation was better in that more than nine times the amount consumed to year-end 1978 remains to be used.

Reading #7: "The Salem Generating Station," Public Service Electric and Gas Company (New Jersey), p. 3.

We are faced with a fuel crisis because of supply, price, and environmental regulations. In the case of oil, reserves in the U.S. are at the lowest point in 20 years. To meet demand, PSE&G imports over 60% of the low-sulfur oil it uses. We import low-sulfur oil because oil with high sulfur emits pollutants when burned and is not environmentally acceptable by law! This dependence upon foreign sources opens serious questions regarding national security and economics. Also, oil prices will continue to rise because of the domestic oil shortage.

Reading #8: from speech by Russel E. Train, Chairman, Council on Environmental Quality, to the American Power Conference, Chicago, Illinois, May 8, 1973. Included in Energy Packet, Massachusetts Audubon Society.

There are some who simplistically blame the strong concern over environmental quality as the cause for our energy problems. This assertion is simply not true....

Environmentalists have also been charged with hindering the construction of new petroleum refineries. Although some companies have been refused sites for new refineries, by and large the oil industry has been reluctant to commit large sums to new refinery construction because of past uncertainty about government policies,

and because of a severe shortage of cash from current company earnings. In addition, for the large international oil companies, extreme uncertainty as to their situation in the Middle East vis-a-vis the Organization of Petroleum Exporting Countries has created a wait-and-see attitude.

Reading #8: from Executive Office of the President, Energy Policy and Planning. The National Energy Plan. Washington, D.C.: Superintendent of Documents, 1977, p. vii.

This diagnosis of the U.S. energy crisis is quite simple; demand for energy is increasing, while supplies of oil and natural gas are diminishing. Unless the U.S. makes a timely adjustment before world oil becomes very scarce and very expensive in the 1980's, the nation's economic security and the American way of life will be gravely endangered. The steps the U.S. must take now are very small compared to the drastic measures that will be needed if the U.S. does nothing until it is too late.

How did this crisis come about? Partly it came about through lack of foresight. Americans have become accustomed to abundant, cheap energy. During the decades of the 1950's and 1960's, the real price of energy in the U.S. fell 28%. And from 1950 until the quadrupling of world oil prices in 1973-74, U.S. consumption of energy increased at an average annual rate of 3.5%. As a result of the availability of cheap energy, the U.S. developed a stock of capital goods--such as homes, cars, and factory equipment--that uses energy inefficiently.

Section 1-4. Views from other countries.

Reading #1: from "Energy and Nuclear Weapon Proliferation--A Japanese Point of View," Kinya Niizeki, Commissioner, Japanese Atomic Energy Commission, Trialogue, Number 15, Fall, 1977, p. 6.

It has become clear that the energy resources of the world are very limited. The contribution of oil to the supply of the world's energy is diminishing rapidly. I should like to point out that recent studies show a rather gloomy picture of the energy situation. According to the CIA report which has been made public some time ago, global oil supplies will begin to fall short of world demand by 1985. This means that the problem of oil shortage will arise earlier than previously expected. I would therefore like to emphasize that it is a categoric imperative for us that every effort should be made to conserve energy resources, making the best use of what energy is available.

The United States is, I should say, unique among the industrialized countries of the Free World for its possession of energy resources. The United States still has an impressive production of oil and gas. Besides, the United States is extremely

well-endowed with coal that can easily be obtained by strip mining. Therefore, the U.S. has energy options which are unfortunately not available to most other industrialized nations. Even with respect to the nuclear option, the U.S. has major uranium resources--nearly half of the known resources of the Free World.

In this connection, it is to be pointed out that the countries which lack domestic supplies of energy resources are facing a much more serious problem than the U.S. in securing for themselves diversified energy sources. Those countries are compelled to rely on world markets for fuel supplies. And the need to substitute fossil fuels by uranium is urgent and critical for them, because no other resources offer so great a potential for filling the gap between the fall of oil and the rise of some alternative sources such as solar energy, geothermal energy and fusion.

I should like to make clear at this point that Japan is the extreme of an industrially most advanced country with a relatively large population that has no indigenous energy sources. That is to say, we are entirely dependent upon energy imports to sustain our national economy. For Japan, a shift of energy supplies from oil to coal means heavy reliance on imports from the U.S. and Eastern Europe. Therefore, we ascribe very much importance to the use of nuclear energy. Here again, as Japan has no domestic uranium supplies, it has to depend totally on imports. And this causes many serious problems in Japan.

Reading #2: from "Energy and Nuclear Weapon Proliferation--A European Point of View," Andre Giraud, President, French Atomic Energy Commission, Trialogue, Number 15, Fall, 1977, p. 8.

Our governments have committed themselves to select a policy of fostering at the same time the aims of non-proliferation and the development of nuclear energy. For us, it is out of the question to jeopardize this development, for two reasons:

The first one derives from the energy supply situation of most European countries, which cannot accept to see their economy become increasingly dependent upon the oil producing countries, and risk to face first an unbearable unbalance of their external trade, and then strangulation when oil will no longer be produced in sufficient quantities either because of normal exhaustion of natural resources, or due to insufficient investments, or to the decision of a cartel or even a single country.

The second reason is linked to our concern about world stability. The experts recently assembled in Istanbul have unanimously agreed that the comparison between provisions on oil demand and supply demonstrates that an unprecedented world energy crisis is due for tomorrow, not the day after.

To overcome that crisis, the world must urgently mobilize

all its means of action, among which nuclear energy must play an essential and large part. Our world, where ideologies, racisms, rich and starving populations are face to face, is not organized to afford, in peace, an energy rationing--and it would be useless, in order to preserve this peace, to have reduced the risks of proliferation, by means which would simultaneously increase the risks of tensions and world conflagration.

Reading #3: from "Eight-Point Program is Recommended for Energy Conservation in Australia," Australia Bulletin, Number 34, October 19, 1977, p. 3.

On the basis that Australian needs for imported oil will increase three-fold over the next seven years, even without increased prices the cost of oil imports will be an increasingly large item in Australia's balance of payments.

In the medium and long-term, other sources of energy must be developed to replace natural oil. These could include greater use of coal from our relatively abundant resources, conversion of coal to liquid fuels, the development of solar energy wherever it can be used effectively, a moderate increased use of our natural gas resources, and possibly the later development of nuclear power under proper safeguards. But these other sources are not likely to have great effect in offsetting oil demand within 20 years, with the possible exception of the greater use of coal. Each would involve major capital investments and major manufacturing and construction activity. "For the immediate future, our only possible corrective action is conservation."

Reading #4: from "Major Austrian Breakthrough in Caloric Energy Production," Austrian Information, Volume 31, No. 5, 1978, p. 2.

The foreseeable exhaustion of fossil fuel supplies and their high price on the world market have added special urgency to the fact that the efficiency of the conversion of caloric energy into electricity has never yet exceeded 46 percent. More than half of the valuable heat produced by the combustion of increasingly scarce energy resources is lost and escapes into air or water. This not only represents an enormous waste of resources, it also constitutes a serious threat to the environment if the thermal energy thus released can not be productively employed for remote heating.

In Austria a new technique is being developed, making it possible to convert 55-56 percent of the gases of a thermal power plant, which reaches temperatures of 1,800 degrees centigrade, into electricity: The Treble Rankine cycle (TRC) process. Austrian government agencies have proposed this process to the International Energy Agency (IEA) as a means of developing new methods of energy conservation. The IEA is now conducting studies, to which the United States, the Federal Republic of Germany, Sweden, Holland, Switzerland and Austria are contributing financially in

order to determine industrial and economic application of the Austrian invention.

Reading #5: from an address by J.P. Gallagher, Chairman and Chief Executive, Dome Petroleum Limited, to the Canadian Society of New York, entitled, Proposals for a More Prosperous Canada, New York, January 18, 1979, pp. 1-2.

Recent political disturbances in Iran, which formerly produced over six million barrels of crude oil per day, are causing the world to draw down oil inventories at more than two million barrels per day. This dramatically shows how delicate the balance has become between world crude oil supply and demand. It also indicates clearly how vulnerable North American life style and security are to events that take place in one single geographical region of the world.

It also underscores again the imperative need to develop North America's massive but undeveloped oil, gas, tarsand, and oil shale potentials.

As most of you are aware, during the next decade we North Americans face massive increases in our trade deficits, a major decline in our living standards, and crippling dependence on foreign fuel supplies unless we act now to reverse this trend...

We North Americans should therefore not be averse to paying at least the world price for oil produced in our countries (when over 50% is returned to us through the various levels of Government) rather than pay the full price for a barrel of foreign-produced oil where none of the benefits accrue to our country and where we drastically distort our balance of trade with the resulting depression of our economies....

I suggest that it is time to face the facts what we must pay at least replacement cost for our oil and gas, which in both of our countries approximately equates to world prices.

Reading #6: from an interview with Foreign Minister, Jean Francoise Poncet on French Television, July 1, 1979, as reprinted by the French Embassy & Information Division, p. 1.

There has to be some understanding, I feel, for those countries whose only resource is oil; they know that while it is still under their feet it retains its full value and that once converted into financial holdings, given inflation, some of these countries could in a relatively short time find their resources depleted... It is quite natural for these countries to worry about their future after the oil runs out, and I think it is understandable for them to ask Europeans and other consumers to make an effort to develop to the fullest all energy resources, oil as well as others.

Reading # 7: from "Schmidt to Push for Cooperative Oil Program" Relay from Bonn: The Week in Germany, June 14, 1979; Volume X, Number 24, p. 2.

Chancellor Helmut Schmidt reported after his return from Washington that, in cooperation with the Federal Republic's Western partners, he plans to push for a program to resolve the problems of oil price increases and shortages. He will advocate such a program at the European Community meeting of Heads of Government in Strasbourg and at the Economic Summit in Tokyo, both scheduled to take place within the next few weeks. Central points in the program, which was presented to the Federal Cabinet on Wednesday are: drastic energy conservation measures; cooperative management between oil producing and consuming countries to avert a world-wide economic crisis; the inclusion of Third World countries, who are major sufferers in the price explosion, in the dialogue; and the development of alternative sources of energy such as coal and solar energy. Schmidt expressed his opinion that nuclear energy--at least as a temporary source--cannot be given up.

Reading # 8: from "Energy: Conservation Measures", Greece, April 1979; Volume V, Number 3, p. 6.

Higher prices for gasoline and other liquid fuels and gas fuels were introduced on April 4 as part of govermental energy conservation efforts. The new price of gasoline ranges between $2.35 and $2.60 per gallon. The government is working out plans for gasoline rationing to be introduced later in the year. Meanwhile, conservation is being sought by a number of other new rules, including strict speed limit enforcement and the restriction of all private cars (with very few exceptions for doctors and other essential drivers) to use on alternate weekends. Another fuel conservation measure is the restriction of most advertising lights (neon signs, etc.) to a three-hour period in winter and a two-hour period in summer.

Reading # 9: from "The Cape Times-Higher Petrol Price", South African Digest, June 15, 1979; pgs. 24 & 25.

The drastic increase in the price of petrol announced yesterday by the minister of economic affairs was, of course, inevitable. Motorists and other consumers have been paying less than cost for several weeks now and the price adjustment was essential on basic business principles, let alone the urgent need to conserve energy.

It is clear that the Republic, in common with the rest of the world, is having extreme difficulty in obtaining adequate crude oil supplies at any price. Hence the other measures announced yesterday to reduce demand, and also the need to go along with them. They could have been worse, and they will be worse

unless appreciable savings are effected or there is a considerable improvement in the supply position.

But to keep the picture in perspective, South Africa is fortunate in having one of the lowest dependencies on oil as an energy source of any developed country in the world. It has the most advanced oil-from-coal technology and vast coal reserves. What is now a crisis of major import could, with careful planning, level-headedness, and a stiff upper lip, yet be turned into a long-term advantage in a world geared to a dying source of energy.

GLOSSARY

barrel--42 U.S. gallons

biomass--plant materials in any form from algae to wood

breeder reactor--a nuclear fission reactor that makes more nuclear fuel than it uses, by changing certain atoms that do not split into atoms that will split.

British thermal unit (BTU)--the amount of heat necessary to raise the temperature of one pound of water 1° Fahrenheit.

Calorie--the amount of heat needed to raise the temperature of one kilogram of water 1° Centigrade.

capital--wealth in the form of money or property; usually means money for investment.

cartel--a group of businesses or countries formed to control production and sale of a product.

Centigrade or Celsius--the metric temperature scale in which the freezing temperature of water is set at 0°, and the boiling temperature at 100°. For conversion from Centigrade to Fahrenheit or vice versa, see the formula in figure 12, p. 20.

chemical energy--a form of energy stored in atoms and molecules which can be released through chemical reactions.

coal--a solid fossil fuel, mostly carbon, formed from the fossil remains of plants

coal gasification--a chemical process to change coal into a fuel similar to natural gas. The advantage of this process is that sulfur and other pollutants in coal can be removed before it is burned.

coal liquification--a chemical process to change coal into liquid fuels similar to gasoline and kerosene.

combustion--the burning of a substance to cause it to release its energy in the form of heat.

crude oil--liquid fuel formed from the fossils of animals and plants at the bottom of ancient seas; petroleum as it comes from the ground.

deforestation--the loss of forest lands to overuse, when the rate of use exceeds the natural rate of replacement.

efficiency--The efficiency of an energy conversion is the ratio of the useful work, or energy output, to the total work or energy input.

elasticity of demand--the amount a consumer can "bend" to the pressure of higher prices, by reducing consumption or paying more, without drastic changes.

embargo--government order prohibiting entry or departure of some or all commercial ships at its ports. The embargo may be directed only at ships going to or coming from a particular country.

energy--the ability to cause change; measured by its effects on matter. The major forms of energy are mechanical, chemical, electrical, nuclear, light and heat.

entropy--the amount of randomness, disorder or chaos in a system. Entropy increases in every change or energy conversion.

exponential growth--growth of any figure at a fixed percent per year; characterized by a fixed doubling time. For example, if a population grows 2% per year, it will double every 35 years.

Fahrenheit--a temperature scale in which the freezing temperature of water is set at 32° and the temperature of boiling water at 212°. For converting from Fahrenheit to Centigrade or vice versa, see the formula in figure 12, p. 20.

fission--the splitting of the nucleus of one atom into two or more smaller atoms, which releases large amounts of energy.

fossil fuel--any naturally occuring hydrocarbon, such as coal, crude oil or natural gas, formed over extremely long periods of time from fossil remains of plants and animals; also includes oil shale and tar sands.

fuel--a form of matter that contains energy concentrated enough to have relatively high power when it is released; any substance that can be expended or used to produce heat or power.

fuel cell--a device similar to a battery in which fuels such as hydrogen gas or methane can be directly combined with oxygen to produce electricity and very little heat; the principal by-products are water or carbon dioxide.

fusion--the process of combining the nuclei of two light atoms to form a heavier atom, releasing great quantities of energy. Fusion energy is still in the research stages; it has not been developed yet for commercial use.

generator--a machine that produces electricity. It uses mechanical energy from steam or falling water to spin a turbine that turns a coil of wire in the presence of a magnetic field. When this happens an electric current is produced.

geothermal--having to do with the heat of the earth's interior; this heat is produced by natural radioactive decay.

gross energy--total energy content of a fuel, before any processing, transporting or conversion.

gross national product (GNP)--the total value of all the goods and services produced by a nation during a year.

heat pump--a device that transfers heat from a cooler region to a warmer one (or vice versa) by using mechanical or electrical energy.

horsepower--equal to 3/4 of one kilowatt or 0.18 Calories per second.

hydroelectric plant--an electrical power plant in which the energy of falling water is converted into electrical energy by a turbine generator.

infrastructure--the group of permanent support systems or facilities that allows the individual parts of a society to work together. Included would be communications systems, transportation, energy distribution, economic institutions and government services.

internal combustion engine--an engine in which power is generated within one or more cylinders by the burning of a mixture of air and fuel, and converted into mechanical work by means of a piston, as in an automobile engine.

kilowatt--a unit that measures the rate at which energy is produced or used; equivalent of ten 100-watt lightbulbs. 1000 kilowatts is one megawatt.

kilowatt-hour--one kilowatt of energy use maintained for one hour.

lead time--the amount of time necessary between the first expenditures on a plant or process and its completion or readiness for full-scale commercial production.

liquified natural gas (LNG)--natural gas that has been cooled to approximately -160°C, at which it becomes liquid and greatly reduced in volume.

natural gas--gaseous fuel formed from the fossils of ancient plants and animals; often found with crude oil.

net energy--energy that remains after a fuel has been mined, transported and refined or converted to a usable form.

nonrenewable energy or resources--forms of energy, notably fossil fuels, whose consumption by humans far exceeds the replacement capabilities of the natural process.

ocean thermal energy conversion (OTEC)--a process of generating electricity by harnessing the temperature differences between surface waters and ocean depths.

oil shale--rock formed by silt and mud settling to the bottom of ancient seas that contains a substance similar to crude oil. Shale oil can be extracted by heating the rock.

OPEC--the Organization of Petroleum Exporting Countries, which aims at developing common oil-selling policies.

power--the rate at which energy is used or generated.

petrochemicals--chemicals derived from petroleum.

petroleum--crude oil.

primary energy--energy in its naturally occuring form, as in coal or oil, before conversion to end-use forms.

recoverable resource--that portion of a resource indicated by geologic studies as being recoverable, but as yet undiscovered and so unproven.

renewable energy or resources--forms of energy or resources whose consumption by humans can be approximately equal to the replacement capabilities of natural processes. Examples include wind and solar power, wood.

reserves--energy resources which have actually been discovered and can be recovered under present economic and technological conditions.

resources--the total amount of a resource estimated to be in one deposit area

secondary recovery--techniques used to recover oil and gas after some of it has already been removed, and the natural pressure in the reservoir or deposit has decreased.

social costs--the negative or positive consequences of an action or policy on the society as a whole.

strip mining--mining for coal or other ores by removing the soil and rock above the coal or ore beds, rather than by tunneling underground.

subsidy--monetary assistance granted by a government to a person or private commercial enterprise.

synthetic fuels (synfuels)--liquid and gas fuels produced from coal by chemical processes; can be substituted for oil and natural gas. [See "coal gasification" and "coal liquification."]

tar sand--a sandy geologic deposit in which a low grade, heavy oil binds the sand grains together.

thermodynamics--the science and study of the relationship between heat and other forms of energy.

turbine--a wheel-shaped engine fitted with a series of curved blades--like the blades of an electric fan. The force of running water or steam turns the blades, which turn the generators that produce electricity.

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This issue, entitled Wood for Energy discusses many aspects of the use of this renewable energy source. The focus is strictly on America, but some of the problems would be the same in developing countries. Also included is an article on the environmental, social and economic impacts of "the wood-for-energy push." An interesting issue, if you can obtain it.

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This K-12 program in environmental ethics focuses on five content areas--ecosystems, population, energy, economics and technology. The materials are interdisciplinary, suitable for inclusion in existing courses, and incorporate such teaching aids as skill drills, simulation games, surveys and model building. The teacher's guide is excellent--a good guide to implementing a new course in any area, and the lesson plans contain many useful ideas. The school district also encourages visitations from interested educators.

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A review of Greece's energy policies, which include the development of hydroelectric plants in cooperation with Bulgaria.

Educational Resources Center. People Count. New Delhi, India: Educational Resources Center, December, 1976. Paperback.

For more data and insight into the population problem which underlies the energy problem, this book is based on comparisons between India and the U.S. It covers a number of factors other than simple numbers of people, including food and energy consumption. Good statistics in this secondary level student text.

Enercom. Energy Sources 78/79. Denver, Colorado: Enercom, 1979. Paperback, $10.95.

A sourcebook on energy companies, particularly in the Rocky Mountain area, with articles on fossil fuels, geothermal, nuclear and solar energy, as well as conservation. Primarily, it covers business information on energy-producing companies. Good source of contact for corporate information, field trips, etc. and for the energy companies' perspective; though somewhat expensive.

Energy & Education. Mary T. McGuire, editor. National Science Teachers Association. Bimonthly newsletter, free.

An excellent source of information on books and materials, conferences and workshops. Ideas for teaching energy are included, as is a section on energy facts. This is a must for anyone teaching about energy; order from the NSTA (see address list following Bibliography).

Energy Policy Project of the Ford Foundation. A Time to Choose-America's Energy Future. Cambridge, Mass.: Ballinger Publishing Co., 1974. Paperback.

The final report of a project designed to identify the nation's energy policy choices. The conclusion is that the U.S. can balance its energy budget by slowing the growth rate in energy consumption, without adversly affecting the economy. A good, comprehensive look at energy in America, including an excellent section on social costs, and a review of U.S. energy policy in the world context. Sections could be used for student readings. This book is also recommended background reading, though it is beginning to get dated.

Energy Research and Development Administration. Energy Films Catalog. Oak Ridge, Tenn.: Energy Research and Development Administration, 1976. Paperback, free.

A 69-page annotated bibliography of films on all aspects of energy. Many are too technical or dull for classroom use, but the films are available on free loan, and some could be used with this case study.

Energy Research and Development Administration. "Energy History of the United States, 1776-1976." Washington, D.C.: U.S. Government Printing Office, 1975. Wall chart, $1.05. Stock Number 052-010-00459-0

A large and interesting wall chart of inventions and events related to energy from 1776 - 1976. Some good data; good for a classroom wall. Also available is a users' manual, So What's New? by Joseph M. Duhert, which explains and elaborates on the chart.

English, Paul Ward. World Regional Geography. New York: Harper's College Press, 1977. Hardcover, $15.00.

An excellent college text which discusses development in history and by world regions. For each area--China, India, The Middle East and North Africa, Tropical Africa, Latin America, Western Europe, Russia, Japan and North America--is an energy and mineral resources map and a review of the nation or area's industrial base. A very good source book and reference for the country energy surveys in chapter 6 of Energy in an Interdependent World.

Executive Office of the President, Energy Policy and Planning. The National Energy Plan. Washington, D.C.: Superintendent of Documents, 1977. Booklet, free. Order stock No. 040-000-00380-1.

The booklet summarizes and reviews the National Energy Plan proposed by President Carter. It is clearly written and can be read by students. The overview of the energy situation and the analysis of its economic, environmental and social impact are particularly worth reading. An essential companion to chapter 6 of Energy in an Interdependent World, for its insight into policy planning.

Federal Energy Administration. The Energy Challenge: An Activity Master Program About Our Energy Past, Present and Future. Washington, D.C.: Federal Energy Administration. Paperback, free.

24 Activity Masters for grades 5-8, bound in a paperback booklet which includes objectives, background, vocabulary and additional activities for each master. Some of the masters are too simplistic for senior high, but others would make good introductory handouts on energy sources and some basic graphs and statistics.

Foreign Policy Association. Great Decisions. New York: Foreign Policy Association, Inc., 1978. Annual Paperback, $4.00 + .40 for postage.

One of an annual series that provides background information and thoughtful discussion questions on major foreign policy issues. The 1978 issue included a section on "Dilemmas of World Energy: What Options for a Fuel-Guzzling Superpower?" that outlined the importance of the problem, its background and its current status, as possible future options. Includes discussion questions, opinion ballot and a list of readings. Excellent summary suited to all levels, high school to adult. The 1979 issue includes the results of the 1978 opinion ballot.

Frank, Helmut J. and Schanz, John J. Jr. The Economics of the Energy Problem. Economic Topic Series. New York: Joint Council on Economic Education, 1975. Paperback, $1.50.

A senior high school or introductory college level unit on the economics of energy supply and demand, and the policy issues involved. It includes a section on teaching about energy economics, with suggested teaching strategies and resources. Also included are different perspectives on the issue from the unions, the oil companies and the scientific community. Good for use as an additional text or for reference on the economic aspect of the energy issue.

Friedman, Milton. "Blaming the Obstetrician." Newsweek. June 4, 1979. p. 70. Weekly periodical, $29.95/year, single copies, $1.25.

The author's opinion is that the oil industry did not produce the gasoline shortage, but that the government did so by legislating a maximum instead of a minimum price for oil. A good, short reading which expresses an interesting viewpoint, though it does not go into detailed explanations.

Gibson, Duncan, ed. World Eagle. 10 issues, $14.00/year.

A periodical for teachers with current world social studies data for reference or classroom use. Good graphs, some on energy.

Global Development Studies Institute. Development and Interdependence: A One-Semester Model Curriculum for Secondary Schools and Undergraduate Colleges. Prepared by Walter Schaeffler and Anne Collier, 1978. Paperback $4.00.

A model for a semester course in development and global concepts, which would ideally precede a semester or unit devoted to Energy in an Interdependent World. The curriculum develops global awareness and an understanding of important world facts and trends, reviews the history of development, and analyzes the issues and elements of development today.

Global Development Studies Institute. Focus on Brazil: A Case Study of Development. Prepared by Deborah L. Truhan, 1977. Paperback, $3.60.

A thorough examination of Brazil's economic and social development, which also reviews Brazil's history and geography. A good reference book for a survey of Brazil's energy policies.

Global Development Studies Institute. Global Development Studies: Model Curriculum for Secondary Schools and Undergraduate Colleges. Prepared by John Rorke, 1973. Paperback, $5.60.

A model for a year-long course in global studies, in which a unit like Energy in an Interdependent World could be ideally taught. The curriculum covers a definition of global development, a historical background and a summary overview.

Global Development Studies Institute. The Local Community and Global Awareness, 1977. Paper, $1.25.

A guide for developing global awareness by linking the local community to the larger world. Some of these ideas and methods could be applied in the energy surveys in chapters 1 and 2 of Energy in an Interdependent World, to emphasize the importance of global interdependence.

Global Perspectives in Education, Inc. Environmental Education-Interdependence: A Concept Approach. David C. King, ed. 1976. Guides, $1.50; Handbooks, $2.00.

A broad interpretation of environmental education to include urbanization, population and cross-cultural attitudes. The Guides provide a framework of lesson ideas and objectives applicable to traditional courses, while the Handbooks contain sample lessons. There are Handbooks and Guides for the four grade clusters--K-3, 4-6, 7-9 and 10-12. No specific lessons on energy are included, but there are some good ideas for related topic areas of environmental education.

Global Education Outreach Project, Grand Rapids Public Schools. Off the Shelf: A Teacher's Guide to Global Education. May, 1978. Paper, free.

A bibliography of books, newsletters, films, publishers' addresses, foreign embassy addresses and foreign language materials. More generally global than specifically on energy, but useful information nonetheless.

Guidance Associates. Global Emergency Series. Filmstrips, $52.50 each, or $159.50 for set of four.

Documentary filmstrips on Values in Conflict, Ecosystem, Food and Population, and Energy, which examine conflicting viewpoints and values.

Hammerstrom, Gary. The Hazards of Nuclear Energy: A Policy and Planning Approach. Learning Packages in Policy Issues, PI-3. Croton-on-Hudson, N.Y.: Policy Studies Associates, 1977. Paperback, $4.00.

A fairly complete discussion of nuclear reactors and their hazards, which covers how the different reactors in the U.S. and Canada work, the radiological hazards of nuclear fuels and wastes, and nuclear power plant evaluation procedures. Somewhat advanced for a high school level, but suited to college or adult work, or as a source of information for a research paper from a non-nuclear industry perspective. PSA has another Policy Issues Series paper by the same author, Energy Consumption and Conservation.

Harris, Marvin. "The Myth of the Sacred Cow." Natural History, March 1967.

An explanation of the cow's important ecological role in India's economy, which points up the Western bias toward technological change, even at the cost of environmental balance. Natural History is published by the American Museum of Natural History, Central Park West and 79th Street, New York, N.Y. 10024. This article is also included in Focus on Global Poverty and Development, Jayne Millar Wood, ed. [See the entry for Overseas Development Council in "Organizations" in this Bibliography for an order address.]

Hatheway Environmental Education Institute. Energy: An Annotated Bibliography of Selected Energy Education Materials. Washington, D.C.: Energy and Education Action Center, 1978. Paperback, free.

A 61-page, annotated bibliography of books, pamphlets, reports, articles, periodicals, simulations and audio-visual materials, teaching guides and bibliographies on energy. Included are materials for elementary, junior high, high school and vocational technical school students, as well as adults. Very helpful for preparing a course or directing student research.

Hayes, Denis. Energy for Development: Third World Options. Worldwatch Paper 15. Washington, D.C.: Worldwatch Institute, December 1977. Booklet, $2.00.

A persuasive and readable booklet pointing out the possibility for Third World nations to develop renewable energy

sources and to avoid the fossil fuel or nuclear "trap." A good companion reading to chapter 4 of Energy in an Interdependent World, this paper focuses on an important aspect of the global energy issue--its effects on developing nations.

Hayes, Denis. Rays of Hope: The Transition to a Post-Petroleum World. New York: W.W. Norton & Company, Inc. 1977. Paperback, $3.95.

A Worldwatch Institute Book which discusses the coming transition from dwindling petroleum resources to renewable resources such as solar energy. Hayes feels a nuclear-powered world offers too many risks, and prefers the solar-powered future he outlines in detail. Interesting, persuasive and optimistic. Selections could be used for student readings.

Hayes, Denis. The Solar Energy Timetable. Worldwatch paper 19. Washington, D.C.: Worldwatch Institute, April 1978. Paperback, $2.00.

A good bit of the paper is adapted from Hayes' book, Rays of Hope, and it serves as a summary of the ideas expressed there--the need and path to a transition from petroleum dependence to use of solar and renewable fuels. Suitable for student readings.

Howard, Godfrey G. "A Second Look at Inflation," Financial Analysts Journal, September-October 1977, pp. 35-47.

A rather technical article, probably not suited for student reading, but examines the possible future sites of oil production and the future relationship between higher prices and larger oil supplies. The economist's view.

Howe, James W. "Energy and Developing Countries." Nineteenth Strategy for Peace Conference Report. October 5-8, 1978, pp. 71-80. Paperback, free.

The conference, sponsored by The Stanley Foundation, included this session briefly summarized by Howe, who outlines the problems clearly and succinctly. It would make an excellent reading for the discussion of developing countries in section 4-11.

Hughes, Patricia. "The Sacred 'Rac'." Learning About Peoples and Cultures. Edited by Seymour Fersh. Evanston, Ill.: McDougal, Littell & Company, 1974. Paperback.

An article about Americans' self destructive and irrational love of the automobile. Very good reading in a whole book

of good readings in cross-cultural awareness. A basic book for global studies teachers.

"Inside the Big Oil Game." Time, May 7, 1979, pp. 70-79. Weekly, $31.00/year.

An article about the big oil companies, explaining their pricing and production policies and their relations with the OPEC countries which control oil supplies. There is also a discussion of the effects of decontrolling oil prices. A good and balanced explanation of energy economics, suitable for student reading.

Interact. "Enterprise: A simulation of the American capitalistic system." Simulation game, $15.00.

Students play roles as bankers, businessmen, brokers, consumers, welfare poor, politicians and lobbyists in this simulation of a free enterprise economy. Moderately difficult, but an interesting way to teach economics for grades 10-12.

Interact. "Trade: A simulation of the pressures and procedures of international commerce." Simulation game, $15.00.

The simulation involves students as decision makers of large industrial countries, medium-sized countries, small raw materials-producing countries and multinational corporations engaged in international trade. Students use research to aid their decision-making, and the Teacher's Guide contains a review of world economic principles. For average to above average students in grades 10-12.

The Inter Dependent. Monthly periodical, $6.00/year.

An international affairs newspaper which focuses on important contemporary issues, such as energy. Produced by the UN Association of the U.S.A., the articles are balanced and readable by students.

James, Nancy Ann. "Staples Saves Energy Energetically." American Education. Volume 14, Number 5, June 1978, pp. 14-19. Periodical, 10 issues, $11.00/year; single copies $1.10.

A description of the comprehensive energy curriculum in Staples, Minnesota (see reference under Staples Energy Program for more information) and its success in the schools.

Karpel, Craig S. "Ten Ways to Break OPEC." Harper's. Volume 258, Number 1544, January 1979, pp. 65-74. Periodical, $11.98/year (monthly).

The author suggests ways to reduce dependence on steady oil supplies from OPEC, and ways to insure OPEC's keeping supplies steady. Ways include producing more oil elsewhere, improving contingency plans and restricting our arms exports. Interesting perspective, even if it may never prove workable.

John Knox Press. Baldicer. Simulation game, $25.00.

Students are food coordinators for a hypothetical country in this game for grades 6-14. They learn the effects of the population explosion, unequal distribution of resources and inflation; all lessons which could easily be applied to a country's energy situation.

Lapham, Lewis H. "The Arabian Oil Bubble." Harper's. Volume 256, Number 1536, May 1978, pp. 10-18. Periodical, $11.98/year.

The article discusses the tendency in the U.S. to blame oil shortages on the mythical omnipotence of the OPEC cartel instead of instituting needed changes and actions. A refreshing change of perspective.

Latour, Lawrence W. Inquiry Experiences in Geography. Lexington, Mass.: Ginn and Company, 1973. Paperback, $3.85.

A secondary-level textbook that begins with geogrpahy basics (latitude, climate) and moves on to issues of population, zoning and land use, economics and the environment. Mostly U.S. centered, although there are some global examples. This would be a good guide or teacher reference for the country energy surveys, which are based on geography. There is a good section on the economic and environmental impact of the Aswan High Dam in Egypt (pp. 137-139).

Lewis, Vivian. "Europe's Oil Imbroglio." The New York Times, Section 3, Sunday, March 26, 1978, pp. 1 & 9.

A description of the energy policies of the European nations, and the effects of oil shortages on their relations with each other.

Martin, James. "The United States and the Energy Crisis: A Study in Economic Decision-Making." The Councilor. Illinois Council for the Social Studies. Volume XXXVIII, Number 1, October 1978, pp. 29-41. Newsletter for members.

A discussion of the 1973-4 energy crisis, the foreign policy ramifications and economic impact of energy policies, and Carter's energy bill. Written for high school teachers.

Massachusetts Audubon Society. Energy Packet. Materials packet, $5.00.

The folder of materials includes 7 energy-related issues of The Curious Naturalist, a magazine aimed at the intermediate grades, but with graphs and illustrations that would be suitable for introductory discussions at the high school level. Also included are a 23-page bibliography of written and audio-visual materials, bibliographies on wind and solar energy, and several copies of Public Service Information, a newsletter with data and brief articles on energy, the environment, and ways to conserve. A very useful packet of materials that could be used directly in the classroom.

McHale, John. World Facts and Trends. Second Edition. New York: Collier Books, 1972. Paperback, $2.95.

This book's data is growing out-of-date, but it is still the best compilation of graphs and data into a comprehensible framework and discussion of world trends and of two major concepts--the "J-curve" produced by exponential growth and the gap between rich and poor nations of the world. Included is a section on energy statistics (pp. 60-71). This is a good source of global statistics.

Mid-America Program for Global Perspectives in Education. Global Perspectives Bibliography. May, 1978. Booklet, free.

An annotated bibliography of background readings and resources for teachers and of classroom materials, including simulation games.

Mihalyi, Louis J. "Legacies of Colonialism: Zambia." Focus. Volume XXIV, Number 10, June 1974. Bimonthly periodical, $10.00/year, single copies, $2.00.

One of a number of issues of Focus covering the geography, culture and development of a particular nation. These would be useful companion materials for the brief surveys of national energy policies in chapter 6 of this case study. Suitable for student reading.

National Assessment of Educational Progress. Energy Knowledge and Attitudes-a National Assessment of Energy Awareness Among Young Adults. Report No. 08-E-01. Paper, $3.75.

The results of a poll on energy related knowledge of adults 26-35, which uncovered a lack of public knowledge of facts on the energy issue. Interesting for comparison with the chapter 1 survey, or to convince parents and administrators of the need for energy education. The results are also

summarized in an article in the December 1978 issue of the NAEP Newsletter (Volume XI, No. 6), single copies of which are free upon request.

National Science Teachers Association. Factsheets. Oak Ridge, Tenn.: Energy Research and Development Association, 1976-1977. Set of 19 leaflets, free.

The Factsheets contain descriptions, data and references on a variety of energy sources, including biomass, wind, solar, geothermal, nuclear and coal. There are also Factsheets on conservation, energy storage, environmental impacts, energy terms, and a bibliography on alternative energy sources. Good references for student reports or teacher background. Definitely worth requesting.

National Science Teachers Association. Interdisciplinary Student/Teacher Materials in Energy, the Environment and the Economy. Washington, D.C.: U.S. Department of Energy, 1977-78. Looseleaf packets, free.

A series of interdisciplinary curricula on energy-related topics for grades 1- 12. The units include a teacher's section and photo-copiable student activity handouts, with good graphs and exercises. The lesson ideas are good, clear and practical. This is a recommended source for lesson suggestions that could be included in a variety of courses. the titles and grade levels are as follows:

The Energy We Use	Grade 1
Community Workers and the Energy They Use	Grade 2
People, Places and Transportation	Grade 3
Networks: How Energy Links People, Goods and Services	Grades 4,5
Bringing Energy to the People: Washington, D.C. and Ghana	Grades 6,7
Transportation and the City	Grades 8,9
Energy, Engines and the Industrial Revolution	Grades 8,9
An Energy History of the United States	Grades 8,9
Mathematics in Energy	Grades 8,9
Energy in the Global Marketplace	Grades 9,10,11
How a Bill Becomes a Law to Conserve Energy	Grades 9,11,12
Agriculture, Energy and Society	Grades 10,11,12
U.S. Energy Policy-Which Direction?	Grades 11, 12

National Resources Defense Council, Inc. NRDC Newsletter, Volume 7, Issue 1, January/February 1978. Periodical.

This issue included a discussion of the fight over the expansion of electric power facilities in the Pacific Northwest of the U.S. The article is rather biased against the power industry, and in favor of the environmentalists, but provides a different perspective on the relationship between energy production and environmental issues.

New York State Alliance to Save Energy, Inc. Energy on Film. New York: NYS Alliance to Save Energy, Inc. 1978. Spiral-bound notebook, $3.00.

A digest of over 160 energy-related films which includes audience level, source, prices and length. The films come from diverse sources such as oil companies, environmental groups and government agencies. The NYSASE has other publications as well, including a good basic paper on "Solar Energy," which describes current and proposed techniques.

"An Oil Crisis: True or False?" Time, April 23, 1979; Vol. 113, Number 17, pp. 60-61. Weekly periodical, $31.00/year.

An interview with five leading independent oil experts, who offer differing interpretations of the seriousness of the oil crisis and its possible solutions. Ideally suited reading for section 1-3 of Energy in an Interdependent World.

The Organisation for Economic Co-operation and Development. The OECD Observer, Number 73, January-February, 1975; Number 85, March, 1977; Number 93, July, 1978. Periodical, $4.50/year, single copies, $1.00.

The OCED Observer is a bi-monthly publication by this group of "Western" countries, mostly European. The issues listed have articles about the energy situations and policies in member countries. Good data for policy studies, and an interesting non-U.S., if still Western, perspective on world issues. Also published in French, s'il vous plait.

Parisi, Anthony J. "Anatomy of the Gasoline Crisis: Its Origins, Reality and Handling." The New York Times, Sunday, July 8, 1979, pp. 1 & 30.

An excellent, carefully and clearly organized article on the reasons for the summer gasoline shortages.

Parisi, Anthony J. "Herman Kahn Revisited." The New York Times, Sunday, February 26, 1978, section 3, p. 1.

An interview with Mr. Kahn, a futurologist, in which he recommends the production of synthetic fuels from shale oil as the solution to the energy problem.

Parisi, Anthony J. "Nuclear Power: The Bottom Line Gets Fuzzier." The New York Times, Sunday, April 8, 1979, Section 3, p.1.

The economics of nuclear power are analyzed with an eye to the costs of safety.

Parisi, Anthony J. "Will Higher Oil Prices Stand Up?". The New York Times, The New York Times International Economic Survey, February 4, 1979, pp. 22-23.

Also in this issue are brief but interesting summaries of national energy policies, "The Diverse National Approaches to Oil."

Pearce-Batten, Anthony. "The Future of Renewable Energy." Focus, Volume 29, No. 3, January-February, 1979. Bimonthly periodical, $10.00/year, single copies, $2.00.

Focus, published by the American Geographical Society, usually covers a country or geographic region, but this issue is about the need for renewable energy sources, particularly in the developing countries, and several of the most feasible alternatives are outlined. This is a good summary and notable for its global perspective on energy alternatives. A good reading for the section on developing countries' options in chapter 4 of Energy in an Interdependent World.

Riding, Alan. "Mexico Grapples with Its Oil Bonanza." The New York Times, Section 3, Sunday, May 7, 1978, p. 3.

A brief survey of the dilemmas of this developing country with vast oil potential and a growing population.

Ruedisili, Lon C., and Firebaugh, Morris W., ed. Perspectives on Energy-Issues, Ideas, and Environmental Dilemmas. New York: Oxford University Press, 1975. Paperback.

A college text that presents in anthology diverse views of experts on the "energy crisis" and the environmental problems posed by various alternatives. The first chapter reviews the background to the present situation, and sets forth some of the basic concepts involved. The central chapters cover fossil fuels, nuclear and alternative energy sources, and the last chapter includes energy policy recommendations. There are very good graphs, pictures and references, and the book would be a good source for student research, though it is pretty technical in parts and generally U.S.-oriented.

Sawhill, John C.; Oshima, Keichi; and Maull, Hanns W. Energy: Managing the Transition. Report of the Trilateral Energy Task Force to the Trilateral Commission. The Triangle Papers: 17. New York: The Trilateral Commission, 1978. Paperback.

An analysis of the risks and problems surrounding energy in the short term (0-5 years), medium term (5-10 years) and the long term (over 10 years) future. The report analyzes the energy policy responses of the U.S., Europe, Japan and Canada in 1973-1977, and makes recommendations for further action. Good reference with a different perspective, though somewhat dry reading.

Schmalz, Anton B., ed. Energy: Today's Choices, Tomorrow's Opportunities, Essential Dimensions in Thinking for Energy Policy. Washington, D.C.: World Future Society, 1974. Paperback, $6.00.

A collection of short articles from a variety of sources, including then-Governor Jimmy Carter and Senator Walter Mondale. Some are good and readable, some are too technical or abstruse; the focus is on policy-making considerations. A mine for readings, handouts, discussion-starters, etc.

Sewell, John W. and the staff of the Overseas Development Council. The United States and World Development-Agenda 1977. New York: Praeger Publishers, 1977. Paperback, $4.95.

The section in this book entitled "A Global Approach to Energy" (pp. 107-110) is a brief, persuasive appeal to the U.S. to treat energy as a global issue and to assume a leadership role in energy policy. A good reading selection.

Simile II. Starpower. Simulation game, $25.00.

In this simulation game, students experience the inequities of a three-tiered, low mobility society. It aids in an understanding of the relative positions of the developed and developing world on a global scale, or of the richer and poorer sections of society on a national scale. You can also write for directions on making your own game.

Smothers, Ronald. "L.I. Town a Pioneer in Recycling Its Garbage Into Electric Energy." The New York Times, Sunday, January 14, 1979, pp. 1 & 46.

A comprehensive account of a working resource-recovery plant on Long Island which produces energy and provides an economically and environmentally sound way to dispose of waste.

Staples Energy Conservation Program. Staples Energy Conservation Program. 1977. Complete set of K-12 packets, $90.40, individual units priced as noted below.

This K-12 energy conservation curriculum is compiled from units developed under a Title IV-C grant. The units contain objectives, activity description, energy concepts, grade level and evaluation suggestions. The units are interdisciplinary and designed for inclusion in existing curricula. They include a Teacher's Guide/Glossary ($2.00); an extensive and helpful Bibliography ($7.75); a Primary Packet, K-3 (68 units, $23.00); an Intermediate Packet, 4-6 (59 units, $17.50); and secondary level packets in Social Studies (30 units, $12.50), Science/Math (17 units, $6.95), Language Arts (10 units, $3.75), Home Economics (21 units, $7.95), Industrial Arts (8 units, $3.75), and Agriculture (8 units, $5.25). The units look practical and solid, particularly the secondary Social Studies, though there is very little discussion of the global aspects of the issues.

Stevens, William K. "Shell Juggles Molecules at its Louisiana Plant." The New York Times, Section 3, Sunday, May 13, 1979, p.1.

Article on the problems that oil refineries must face in planning production.

Stobaugh, Robert and Yergin, David, ed. Energy Future. Report of the Harvard Business School's Energy Project. New York: Random House, 1979.

Not yet formally published at the time this entry was written, but cited in a New York Times article of July 12, 1979. This is the result of a six-year study of the nation's energy problems. Stobaugh, Yergin and the six other contributors call for a national policy encouraging greater conservation and solar energy development, as well as growth in coal use, some nuclear power and development of synthetic fuels.

Stoker, H. Stephen; Seager, Spencer L.; and Capener, Robert L. Energy from Source to Use. Glenview, Illinois: Scott Foresman and Company, 1975. Paperback.

A college-level text that compiles facts from a wide variety of sources to allow students to draw their own conclusions on the energy issue. The book reviews the background of the crisis and the nature of energy, but is primarily a discussion of current and proposed energy sources, including conservation. Many good graphs, charts and illustrations, as well as suggested readings in each area. Good for reference, but somewhat advanced for use as a general text on the high school level.

Stoner, Carol Hupping, ed. Producing Your Own Power: How to Make Nature's Energy Sources Work for You. Emmaus, PA: Rodale Press, Inc., 1974. Hardback, $8.95.

A detailed, practical guide to small-scale power production, including wind generators, hydroelectric dams, wood stoves, methane gas digesters and solar space and water heating. A good guide for an ambitious science-class project, or a resource for more practical information on these energy alternatives.

Superintendent of Documents. Selected U.S. Government Publications. Pamphlet, free.

Issued about 10 times a year, the list includes a variety of materials. There is a subheading for "Energy & Environment." Most materials are rather technical and quite dry, but provide important data for research papers, etc.

Swedish Information Service. Human Environment in Sweden. Leaflet, free.

This newsletter appears frequently, with interesting articles about Swedish programs and policies, particularly in the area of energy. Sweden is "ahead" in forward-planning of energy policies and needs and is thus interesting as an experimental situation for policies that might be practical in the U.S.

Terry, Mark and Witt, Paul. Energy & Order. San Francisco, CA: Friends of the Earth, 1976. Paperback, $3.00.

Subtitled, "If You Can't Trust the Law of Conservation of Energy, Who Can You Trust?", this program was originally designed as the last 4-5 week unit of a 10th grade General Biology course. It is designed to develop energy vocabulary and concepts, then to develop ability to analyze energy and order relationships of a system, then to apply this analysis to systems and issues important in our lives. It starts from a basic science unit and moves to consideration of the ethical choices posed by global issues such as population and food supply. A worthwhile purchase for the clearly-written lesson suggestions.

The Trilateral Commission. Trialogue, No. 15, Fall 1977. Periodical.

This issue of the Commission's quarterly bulletin assesses nuclear energy and proliferation policies from the U.S., Japanese and European perspectives for comparison.

Truran, H.C. A Practical Guide to Statistical Maps and Diagrams. London: Heinemann Educational Books, 1975. Paperback, $3.25.

A technical guide to making statistical maps and graphs, such as bar graphs, pie charts, etc. This upper secondary level text includes a good bit of global data in its examples, and would be suitable as a teacher reference for teaching map skills or basic statistical skills.

United Nations. UN Statistical Yearbook. Annual publication, Paperback, $37.00.

The U.N. yearbook is the best source of economic and social data on the world's nations. You can write for more information to: Department of International Economic and Social Affairs, Publishing Office, United Nations, New York, NY. 10017.

United Nations Association of the United States of America. Science and Technology in an Era of Interdependence. 1975. Paperback, $2.00.

This report gives an overview of global issues, including energy, and how they are affected by technology. Its recommendations emphasize the need for global cooperation and offer concrete suggestions for action in using science and technology to approach global problems.

The United Nations Educational Scientific and Cultural Organization. The Unesco Courier. June, 1978. Periodical, free.

This issue of the Courier is filled with articles on the energy alternatives available, such as nuclear power, geothermal, wind, coal, biomass and hydrogen. Many photographs and frequent mention of other countries' projects in these survey articles. Possible reference source for the research into alternatives suggested in chapter 5 of this study, or for information on international cooperation.

United States Department of Energy. Citizens' Workshops on Energy and the Environment Handbook. Washington, D.C.: Department of Energy, 1978. Booklet, free.

The handbook describes the Citizens' Workshops which can be arranged through the Department of Energy, and also gives background information on energy and the environment. Includes a survey, brief reference bibliography and a glossary. A good and very readable introductory handout, but no detailed analysis.

United States Department of Energy. Energy in Focus-Basic Data. Washington, D.C.: Department of Energy. January 1978. Pamphlet, free.

Tables of statistics on U.S. energy production and consumption, including fossil fuels, nuclear and electrical energy. These tables will be updated periodically and broadened to provide more comprehensive data on the domestic energy situation. Dry but useful reference material.

U.S. Department of Energy. Energy Trails: A Guidebook Describing Energy Sites, Power Plants, Science Museums, and Other Interesting Places: Northeastern States. Paperback, free.

The book describes 23 sites from Boston to Maryland, and provides historical information. Write for other regional guides, if needed. A very useful book for planning field trips or suggesting extra projects.

U.S. Department of Energy, Assistant Secretary for Conservation and Solar Applications. Tips for Energy Savers. March 1978. Booklet, free.

A very useful booklet of 46 pages, which begins with a short rationale for increased conservation, then lists hundreds of ways to save energy at home, on the road and in the marketplace. Many are common sense, some you may not have though of, but this booklet should be sent home as required reading by everyone in the family! For single copies, write "Tips for Energy-Savers," Pueblo, CO 81009. For bulk copies, write the Dept. of Energy [address listed, p. 159].

U.S. Department of Energy, Assistant Secretary for Conservation and Solar Application, Office of Marketing and Education. Your Energy World. February, 1978. 4 sets of activity masters plus teacher's guides, single copies, free.

Although aimed at grades 4-6, some of the duplicating masters, such as the road survey or home appliance survey could be adapted for use as simple, introductory activities for a high school course. The guides suggest teaching strategies and additional activities.

U.S. Department of State. Gist. Bulletin, free.

A reference aid on U.S. foreign relations, Gist appears frequently on a variety of topics, including "Oil and Energy" in January, 1979. It's succinct and contains a fair amount of good data--a good mailing list to get onto. Also available are short, factual summaries of 160 countries, Background Notes, at $.50 per copy, and color maps of countries at $.75 each. Write the Superintendent of Documents for information.

U.S. Department of State. The United States and World Energy. A Discussion Paper. Department of State Publication 8904. Washington, D.C. : Bureau of Public Affairs, November, 1977. Pamphlet, free.

The paper is not a policy statement, but a compilation of some essential facts and alternate views on a major foreign policy question. It is very readable and suitable for student use as an additional text. It includes photographs, charts and a brief bibliography of references available from the government.

University of Illinois, Visual Aids Service. Catalog. Booklet,free.

There are separate catalogs for each subject area (geography, history, social science, science, etc.), which describe this extensive and inexpensive source of educational films for rent.

Washington State Office of Public Instruction, Office of Environmental Education. Energy, Food and You: An Interdisciplinary Curriculum Guide for Secondary Schools. 1976. Paperback, $5.00.

An interesting series of activities, well written and illustrated with charts and graphs. Its four major sections are: Global Food and Resource Needs, Basic Characteristics of Energy, Energy and the U.S. Food System, and Energy-Efficient Alternatives. The lessons are also cross-indexed by subject area--science, English, art, social studies, horticulture/vocational agriculture, math, industrial arts, home economics. The material is somewhat more international than most and well worth obtaining. Order from: Christina Peterson, Energy, Food, and You Program, ESD # 121, c/o Shoreline School District, N.E. 158th and 20 Avenue, N.E. Seattle, Wash. 98155. (Make checks payable to "Educational Service District # 121.)

Western Publishing Co., Inc., School and Library Department. "Economic System." Simulation game.

The game simulates the interdependence of laborers, farmers, manufacturers and energy producers in an economic system. It is high school level and requires three class periods. Order from Western Publishing Co., Inc., 850 Third Avenue, New York, NY 10022.

Walt Disney Educational Media Company. Mickey Mouse and Goofy Explore Energy Conservation and Mickey Mouse and Goofy Explore Energy.

Aimed at the upper elementary to junior high level, these comic books briefly review U.S. energy history and suggest

conservation techniques. They are available in limited quantities without charge from: Public Affairs Department, Exxon, U.S.A., P.O. Box 2180, Houston, Texas 77001.

Workshop on Alternative Energy Strategies. Report of the Workshop on Alternative Energy Strategies. Energy: Global Prospects 1985-2000. New York: McGraw-Hill Book Company, 1977. Paperback, $6.95.

This report, sponsored by the Massachusetts Institute of Technology, is a basic reference on the future of the energy situation because of its careful and detailed analysis of the factors involved. It projects a number of scenarios for world energy in general, and for each major fuel in particular, based on different assumptions of economic growth, oil price and national policies. Included is an appendix on the prospects for the developing countries. This is an excellent and widely respected reference with some good graphs and statistics and gives good summaries of the situation for the fossil fuels, nuclear energy and the main renewable sources, but much of it is difficult for the average students.

World Bank. Press Releases, January 17, 1979, "World Bank to Expand Lending for Oil and Natural Gas." Paper, free.

The World Bank is now involved in lending to developing countries money for energy projects. The Press Releases are brief summaries of the proposed projects and their intended results. Useful information for the country surveys of energy policies in chapter 6 of this study.

World Bank. World Atlas of the Child. Washington, D.C.: World Bank, 1979. Paperback, free.

Data on population, gross national products, birth and death rates, and life expectancy, as well as special information on the number, education and condition of children in the world's nations. The data is presented in tables or on shaded maps. Good basic reference; the first two pages could provide students with a clear world map, if individual copies were handed out.

Yager, Joseph A.; Steinberg, Eleanor B., et al. Energy and U.S. Foreign Policy. Cambridge, Mass.: Ballinger Publishing Company, 1975. Paperback.

A very helpful analysis of some of the international aspects of energy policy, prepared for the Energy Policy Project of the Ford Foundation. The book reviews the world energy problem and the world energy market before surveying the policies and outlooks of the oil-exporting and oil-importing

countries, the Soviet Union and China. It explores the implications of the world oil balance and of the growth of nuclear energy, concluding with a discussion of U.S. energy policy. The information is getting somewhat out-of-date, but the book covers energy as a global issue--something few others do--and it is quite readable as well. A good resource.

Yergin, Daniel. "The Real Meaning of the Energy Crunch" New York Times Magazine, Sunday, June 4, 1978, p. 32.

Excellent and readable article on how the energy issue affects the relationships between the U.S. and OPEC countries, and between the U.S. and the Soviet Union, and the future implications of foreign policy. A good discussion of energy as a global and political issue, it would be a good handout for an introductory reading or a reading for chapter 4 of this study.

ORGANIZATIONS

American Gas Association
1515 Wilson Boulevard
Arlington, Va. 22209

Write for "Educational Services Energy Newsletter," a series of educational leaflets on various aspects of energy production, use and conservation, with emphasis on natural and synthetic gas. These are free upon request. Also available are a newsletter on gas supplies called "Natural Gas Update" and a more general newsletter called "Energy Analysis."

American Petroleum Institute
2101 L Street, N.W.
Washington, D.C. 20037

Write for their current catalog of publications and materials. The Public Relations, Special Issues, and Statistics sections include inexpensive material of general interest, such as a pamphlet on "Why Gasoline Prices Vary" and a booklet of "Facts About Oil."

Aramco Services Company
1100 Milam
Houstan, Tex. 77002

Aramco is the Saudi Arabian oil consortium. They publish a free, bimonthly magazine, "Aramco World Magazine" which is worth ordering for a different oil company perspective.

Australian Information Service
Australia Bulletin
636 Fifth Avenue
New York, N.Y. 10020

Write for their free newsletter on Australian affairs and policies.

Austrian Information Service [The]
31 East 69 Street
New York, N.Y. 10021

Write for their free bulletin on Austrian affairs, "Austrian Information."

Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
Attn: Mr. Richard J. Anderson, Associate Director of the Battelle Energy Program and Editor of "Energy Perspectives."

Write for a list of Battelle's published papers, or for "Energy Perspectives," educational leaflets on various energy sources. Of these latter, only a limited number are still available, but they are concise and clearly written.

Carrier Corporation
Energy Systems Division
P.O. Box 100
Syracuse, N.Y. 13201

Write for information on their solar energy equipment and research. Their booklet, "Putting solar energy to the test," includes sketches and descriptions of the solar collectors, heating systems, cooling system, water heating and data collection for Carrier's experimental house in Naples, Florida.

Center for Renewable Resources
1028 Connecticut Avenue, N.W. #1100
Washington, D.C. 20002

Write for brochure, "Solar Lobby Sundries," of information from this lobbying organization that supports solar energy research and development. Some of their materials are aimed specifically at energy educators.

Colombia Information Service
Colombian Center
140 East 57 Street
New York, N.Y. 10022 (212) 421-8270

Write for information and the newsletter, Colombia Today, which reports on development of Colombia's power resources and energy policies.

Con Edison
4 Irving Place
New York, N.Y. 10003

Write for information and brochure, "An Energy Strategy for New York City in the 1980's" by Charles F. Luce, Chairman of the Board of this utility company which serves the New York City area.

Division of Conservation Research and Technology
ERDA
Washington, D.C. 20545

Write for information and descriptive leaflet on fuel cells and their use in electric power generation.

Dome Petroleum Limited
P.O. Box 200
Calgary, Alberta T2P 2H8 Canada

Write for information and viewpoints from this North American, but non-U.S., oil company.

Edison Electric Institute
90 Park Avenue
New York, N.Y. 10016

Write for information on the energy industry, and for a copy of the executive summary of "Economic Growth in the Future," which connects energy with economic issues.

Electric Power Research Institute
Communications Division
P.O. Box 10412
Palo Alto, Cal. 94303 (415) 855-2000

Write to them for a list of publications or their reference book, "Efficient Electricity Use," if you have budding engineers in your class, or are interested in more technical information about conserving electrical energy in the home and elsewhere. Most of the publications are quite advanced in nature, but some might provide information for student research in specific areas. Ask for the Information Service catalog, which lists non-technical materials, as well as films and audio-visual materials.

Energy and Education Action Center
Dr. Wilton Anderson, Director
U.S. Office of Education
Room 514, Reporters Building
300 7th Street, S.W.
Washington, D.C. 20202 (202) 472-7777

The Center's activities include assisting potential grantees in learning about energy-related funding, publicizing materials available from the government, and assisting in the development of public awareness of energy education needs in appropriate conferences, workshops and seminars.

Energy Conservation and Environment
Federal Energy Administration
Washington, D.C. 20461

Write for leaflet, "Don't Be Fuelish," with 30 ways to conserve gasoline.

Exxon Corporation
Public Affairs Department
1251 Avenue of the Americas
New York, N.Y. 10020

For proportional maps of oil reserves and consumption, Exxon's annual review, and the Exxon Background Series, which includes titles such as "Middle East Oil," "World Energy Outlook," and "Environmental Conservation--A Progress Report." Some of the materials are a little advanced for high school use, but certain information and graphs are useful at all levels.

Exxon Film Library
Modern Talking Picture Services, Inc.
2323 New Hyde Park Road
New Hyde Park, N.Y. 11040

Write for information on 16 mm color and sound films available on a free loan basis. Produced by Exxon, the films cover such subjects as the relationship of energy and the environment or offshore petroleum production. Most of the films are 27 1/2 minutes in length, and would be useful as presentations of the oil company's perspective.

French Embassy
972 Fifth Avenue
New York, N.Y. 10021 (212) 570-4400

Write for fact sheets, press releases and their newsletters for information on the energy programs in France, including their nuclear power plants, breeder reactor program, tidal power station and solar blast furnace.

Friends of the Earth Books
124 Spear Street
San Francisco, Cal. 94105

Write for their publications list, which focuses on environmental issues. There are several titles on energy, particularly in the "soft energy" alternatives.

Gas Research Institute
10 West 35 Street
Chicago, Ill. 60616

For information on natural gas, synthetic fuels from oil and shale; "Energy and Society," text of a symposium presentation by Henry R. Linden analyzing energy's public policy implications; "Perspectives on U.S. and World Energy Problems" with basic graphs and statistics compiled by Henry R. Linden, Joseph D. Parent, and J. Glenn Seay of the Institute of Gas Technology.

German Information Center
410 Park Avenue
New York, N.Y. 10022

Write for "The Week in Germany," a prolific and informative bulletin on current German affairs.

Hammond Map Company
Education Division
515 Valley Street
Maplewood, N.J. 07040

Write for a list of maps, atlases and other publications for student use and classroom reference.

International Energy Agency
2, rue Andre Pascal
S-75775 Paris
Cedex 16
France

Write for information about this consortium of oil-importing countries, which has attempted to unify national policies and make provisions for emergency oil-sharing.

National Energy Foundation
366 Madison Avenue, Suite 705
New York, N.Y. 10017

Write for information on organizations in the energy field and on alternative energy sources, as well as bibliographical information on available resources.

National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

Write for publications list, which includes energy-related materials for all grade levels. The NSTA authored the 1-12 curricula distributed by the Department of Energy.

National Solar Heating and Cooling Information Center
P.O. Box 1607
Rockville, Md. 20850

Write for their bibliography of films, the factsheet on insulation, list of publications on solar energy, and bibliography of energy education materials. The Center is operated by the Franklin Research Center for the U.S. Department of Housing and Urban Development and the U.S. Department of Energy. Also available from them is a booklet on "Solar Energy and Your Home," with practical answers to frequently asked questions.

New Jersey Department of Energy
Office of Information Services
101 Commerce Street
Newark, N.J. 07102

Write for information on state laws, programs and materials on energy, including the free newsletter, Energy Exchange. In New Jersey, you can call a toll-free energy Informationline for information: (800) 492-4242. The state departments of energy have news about local energy conferences and expositions, as well as state regulations. Contact your state's department for more information.

Overseas Development Council
1717 Massachusetts Avenue, N.W.
Washington, D.C. 20036

A source of materials and information about development and developing countries. Write for more information. ODC also produced an excellent and extensive compilation of readings suitable for any global studies class. Contact Jayne Millar Wood for information on its availability. (It may well be out of print.)

Plasma Physics Laboratory
Information Office
Princeton University
P.O. Box 451
Princeton, N.J. 08540 (609) 452-5373

Write for information on the nuclear fusion research going on there. Their Information Bulletin and booklet on the Tokamak Fusion Test Reactor have some less technical sections that could be used in a research project on fusion. The laboratory also gives tours, if you're within driving distance and want to see high technology at work.

Public Service Electric and Gas Company
Information Services Department
70 Park Place
Newark, N.J. 07101

Write for an annual review of PSE&G activities; "The Energy Outlook," a summary review of energy alternatives; "Nuclear Energy--Questions and Answers," a descriptive booklet on the Salem Nuclear Generating Station; and a booklet on "Energy and the Environment." Also available is a pamphlet on "The Electric Heat Pump," a device which makes heating and cooling systems more efficient.

Republic of South Africa
Consulate General
Information Service
425 Park Avenue
New York, N.Y. 10022

Write for their weekly publication, "South African Digest," which represents the official apartheid view of South Africa.

Texaco, Inc.
Public Relations Division
2000 Westchester Avenue
White Plains, N.Y. 10650

Write for information on Texaco's activities in oil and natural gas production.

U.S. Atomic Energy Commission
Technical Information Center
P.O. Box 62
Oak Ridge, Tenn. 37830

Write for free booklets (requests must be made on school or library stationery) on all aspects of atomic energy. Booklets of general interest on a non-technical level include "Atomic Energy and Your World," "A Bibliography of Basic Books on Atomic Energy," and "Nuclear Power Plants." Or write for the "Index to AEC Information Booklets" for more titles and information.

ADDRESSES FOR CITED REFERENCES AND ADDITIONAL INFORMATION

The African-American Institute
833 United Nations Plaza
New York, N.Y. 10017

Ag World
1186 West Summer Street
St. Paul, Minn. 55113

Agency for International Development
Office for Public Affairs
Washington, D.C. 20523

American Association for the Advancement of Science
Science magazine
1515 Massachusetts Avenue, N.W.
Washington, D.C. 20005

American Education
U.S. Office of Education
Washington, D.C. 20202
or
for subscriptions and orders:
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

The American Forestry Association
1318 Eighteenth Street, N.W.
Washington, D.C. 20036

American Journal of Physics
American Association of Physics Teachers
State University of New York
Graduate Physics Building
Stony Brook, N.Y. 11701

Antioch Community Schools District 34
Attn: Michael D. Teeley
600 Highview Drive
Antioch, Ill. 60002

Atlas: World Press Review
Subscription Department
Box 2550
Boulder, Col. 80302

Ballinger Publishing Company
17 Demster Street
Harvard Square
Cambridge, Mass. 02138

CESI
United Nations
Palais des Nations
CH-1211 Geneva 10
Switzerland

Center for Ethics and Social Policy
Graduate Theological Union
2465 Le Conte Avenue
Berkeley, Cal. 94709

Center for Teaching International Relations
University of Denver
Denver, Col. 80208

Collier Books
Macmillan Company
866 Third Avenue
New York, N.Y. 10022

Committee for Economic Development
477 Madison Avenue
New York, N.Y. 10022

Thomas Y. Crowell Company
666 Fifth Avenue
New York, N.Y. 10019

Current History
4225 Main Street
Philadelphia, Pa. 19127

Educational Resources Center
Director, Center for International Programs
State Education Department
University of the State of New York
Albany, N.Y. 12230

The Embassy of Greece
Office of Press and Information
2211 Massachusetts Avenue, N.W.
Washington, D.C. 20008

Enercom
909 17th Street
Suite 601
Denver, Col. 80202

Energy Research and Development Administration
Technical Information Center
P.O. Box 62
Oak Ridge, Tenn. 37830

Federal Energy Administration
The Energy Challenge
Box 14306
Dayton, Ohio 54514

Financial Analysts' Journal
219 East 42 Street
New York, N.Y. 10017

Focus
American Geographical Society
Broadway at 156th Street
New York, N.Y. 10032

Foreign Policy Association
345 East 46 Street
New York, N.Y. 10017

FORTUNE
541 North Fairbanks Court
Chicago, Ill. 60611

Friends of the Earth Books
124 Spear Street
San Francisco, Cal. 94105

Ginn and Company
191 Spring Street
Lexington, Mass. 02173

Global Development Studies Institute
Millbrook School
Millbrook, N.Y. 12545

Global Education Outreach Project
Grand Rapids Public Schools
143 Bostwick Avenue, N.E.
Grand Rapids, Mich. 49503

Global Perspectives in Education, Inc.
218 East 18 Street
New York, N.Y. 10003

Guidance Associates
757 Third Avenue
New York, N.Y. 10017

Harper & Row Publishers, Inc.
10 East 53 Street
New York, N.Y. 10022

Harper's College Press
10 East 53 Street
New York, N.Y. 10022

Harper's Magazine
1255 Portland Place
Boulder, Col. 80323

Hatheway Environmental Education Center
Massachusetts Audubon Society
Lincoln, Mass. 01773

Heinemann Educational Books, Ltd.
4 Front Street
Exeter, N.H. 03833

Illinois Council for the Social Studies Newsletter
D.L. Schillings, Editor
Homewood-Flossmoor High School
999 Kedzie Avenue
Flossmoor, Ill. 60422

Interact
Box 262
Lakeside, Cal. 92040

The Inter Dependent
300 East 42 Street
New York, N.Y. 10017

John Knox Press
Box 1176
Richmond, Va. 23209

Joint Council on Economic Education
1212 Avenue of the Americas
New York, N.Y. 10036

Massachusetts Audubon Society
Education Department
Lincoln, Mass. 01773

McGraw-Hill Book Company
1221 Avenue of the Americas
New York, N.Y. 10036

Mid-America Program for Global Perspectives in Education
Indiana University
513 North Park Avenue
Bloomington, Ind. 47401

The Nation
Nation Associates, Inc.
333 Sixth Avenue
New York, N.Y. 10014

National Assessment of Educational Progress
Suite 700
1860 Lincoln Street
Denver, Col. 80295

National Resources Defense Council, Inc.
122 East 42 Street
New York, N.Y. 10017
or
917 15th Street, N.W.
Washington, D.C. 20005

National Science Teachers Association
1724 Connecticut Avenue, N.W.
Washington, D.C. 20009

New York State Alliance to Save Energy
36 West 44 Street
Room 709
New York, N.Y. 10036

The New York Times
229 West 43 Street
New York, N.Y. 10036

Newsweek
The Newsweek Building
Livingston, N.J. 07039

The Organisation for Economic Co-operation and Development
Publications Center
Suite 1207
1750 Pennsylvania Avenue, N.W.
Washington, D.C. 20006

Oxford University Press, Inc.
200 Madison Avenue
New York, N.Y. 10016

Policy Studies Associates
P.O. Box 337
Croton-on-Hudson, N.Y. 10520

Prentice-Hall, Inc.
Englewood Cliffs, N.J. 07632

Praeger Publishers
200 Park Avenue
New York, N.Y. 10017

Rodale Press, Inc.
33 East Minor Street
Emmaus, Pa. 18049

Saturday Review
P.O. Box 10007
Des Moines, Iowa 50348

Scott, Foresman and Company
1900 East Lake Avenue
Glenview, Ill. 60025

Simile II
218 12th Street
Box 910
Del Mar, Cal. 92014

The Stanley Foundation
Stanley Building
Muscatine, Iowa 52761

Staples Energy Conservation Program
Independent School District 793
Staples, Minn. 56479
[Make check payable to "Energy Office."]

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Swedish Information Service
Swedish Consulate General
825 Third Avenue
New York, N.Y. 10022

Time Magazine
541 North Fairbanks Court
Chicago, Ill. 60611

Today's Education
National Education Association
1201 16th Street, N.W.
Washington, D.C. 20036

The Trilateral Commission
345 East 46 Street
New York, N.Y. 10017

United Nations Association of the United States of America
300 East 42nd Street
New York, N.Y. 10017

Unesco
The Unesco Courier
Rene Caloz, Editor-in-Chief
Place de Fontenoy
75700 Paris
France

U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, Tenn. 73830

U.S. Department of State
Bureau of Public Affairs
Washington, D.C. 20525

U.S. News and World Report, Inc.
2300 N Street, N.W.
Washington, D.C. 20037

University of Illinois
Visual Aids Service
Champaign, Ill. 61820

W.W. Norton & Company, Inc.
500 Fifth Avenue
New York, N.Y. 10036

World Bank
1818 H Street, N.W.
Washington, D.C. 20433

World Eagle
Duncan Gibson, Editor
64 Washburn Avenue
Wellesley, Mass. 02181

World Future Society
4916 St. Elmo Street
(Bethesda)
Washington, D.C. 20014

Worldwatch Institute
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Other Publications Available from GDSI:

Development and Interdependence: A One-Semester Model Curriculum for Secondary Schools and Undergraduate Colleges, with teacher's guide and extensive annotated bibliography. 100 pages. $4.00

Global Development Studies: Model Curriculum for Secondary Schools and Undergraduate Colleges, one-year course design with bibliography and list of reference organizations. 71 pages. $5.60

Focus on Brazil: A Case Study of Development, model country case study with selected bibliography and glossary. 138 pages. $3.60

World Food Supply: A Global Development Studies Case Study, with extensive instruction guide, selected bibliography. 110pp. $2.60

Does It Work? Evaluation Guidelines for Global Studies Teachers, to help educators with the basic steps in the course evaluation process. 30 pages. $2.60

The Local Community and Global Awareness, some 60 classroom activities. (An adaption for use with visually handicapped students is also available.) 13 pages. $1.25

All prices are subject to change.